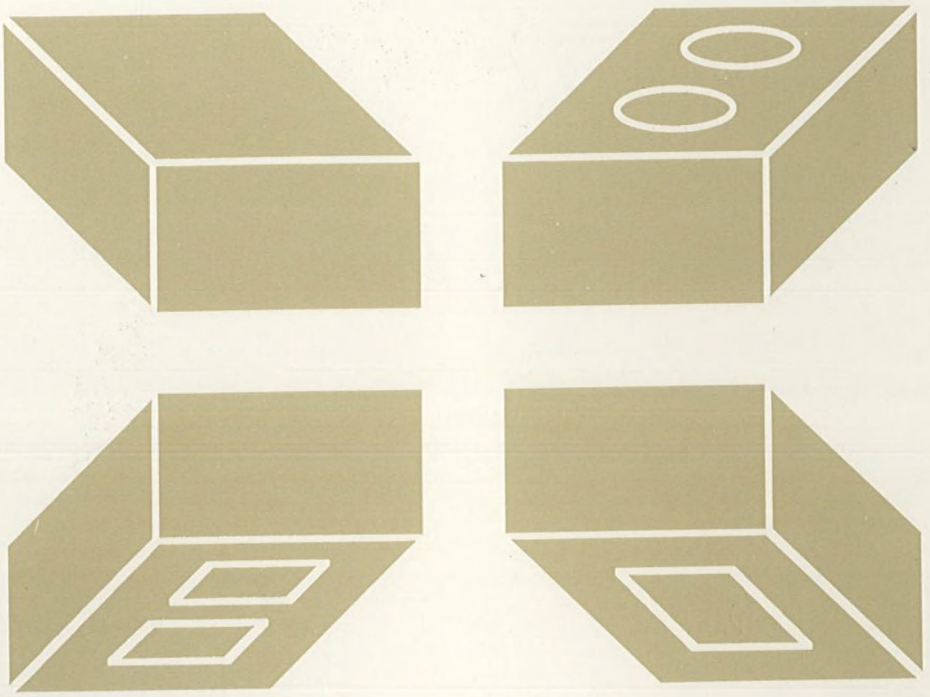
COMPRESSED EARTH BLOCKS

SELECTION OF PRODUCTION EQUIPMENT



CENTRE FOR
THE DEVELOPMENT
OF INDUSTRY
(ACP-EEC)

COMPRESSED EARTH BLOCKS

SELECTION OF PRODUCTION EQUIPMENT

Centre for the Development of Industry (ACP-EEC Lomé Convention)
Rue de l'Industrie 28 - 1040 Brussels, Belgium
Telephone : (32) 2 513 41 00 - Telex : 61427 CDI B - Telefax : (32) 2 511 75 93

CRATerre : HOUBEN, H. ; VERNEY, P.E.
with the participation of MAINI, S. CRATerre
and WEBB, D.J.T. Building Research Establishment, Overseas Division

COMPRESSED EARTH BLOCKS : SELECTION OF PRODUCTION EQUIPMENT

72 pages
CDI, Brussels, January 1989

Raw earth / Stabilized earth / Brickworks /
Production equipment / Presses / Pulverizers / Sieves / Mixers
Parameters / Criteria / Selection

This guide has been compiled with the help of specialist experts from :

CRATerre,
International Centre for the Research and the Application of Earth Construction,

on the basis of information supplied by the various establishments featuring in the guide. Although every possible effort has been made to ensure that data is correct and up-to-date, CDI (Centre for the Development of Industry) cannot be held responsible for any inaccuracies or gaps in the information included in this guide. The fact that an establishment is mentioned in this guide does not imply any obligation to supply any of the services described under any heading.

CDI provides the information contained in this document in good faith. It cannot accept responsibility for errors, omissions, or their consequences.

UDC 691.41

g1

Si/SfB

PURPOSE

This guide is specifically devoted to the selection of equipment intended for the production of compressed earth blocks.

An inventory of equipment currently marketed by firms from EEC (European Economic Community) States is included.

In order to help entrepreneurs in ACP (African, Caribbean and Pacific) States to make an appropriate choice, the equipment is presented in a uniform manner throughout. This facilitates comparison of the various features.

An equipment selection procedure is proposed, based on criteria which are described in detail.

The guide includes a questionnaire. When filled in, this questionnaire should enable decision-makers to make their own equipment selection in full awareness of the facts, or to entrust selection to a neutral specialist organization.

The guide is also available in French under the title : "BLOCS DE TERRE COMPRIMÉE : CHOIX DU MATÉRIEL DE PRODUCTION".

CAUTIONARY NOTE

The launching of a new construction industry necessarily involves several stages, usually defined as follows :

Stage 1 :
Preliminary studies which include the identification of the projects, the preliminary feasibility study, the provisional timetable, etc.

Stage 2 :
Studies which include the feasibility study, the market survey, equipment selection, the operating plan, etc.

Stage 3 :
Project implementation which covers many activities such as the installation of construction material production units, training programmes, the compilation of plans and dossiers, the building of prototypes, project construction, etc.

Stage 4 :
Evaluation which may be continuous, covering technical, economic, social and other aspects.

The present document refers to Stage 2, and enables decision-makers to make an adequate and fully-informed choice of equipment for brickworks producing compressed earth blocks.

The units of measurement used in the present document are, as far as possible, in accordance with ISO recommendations.
In particular, the unit of pressure used is the MPa.
1 MPa = 1 MN/m^2 = 10 bars.

PREFACE

Raw earth has been used to construct buildings since the most remote times, as illustrated by traditional accommodation in many regions of our planet. Having been abandoned and forgotten with the advent of industrial construction materials, particularly concrete and steel, raw earth is now the subject of a revival in interest, particularly in developing countries but also in industrial countries.

This material, often criticized for its sensitivity to water and lack of durability, offers numerous advantages in its current form for the building of low-cost housing. When employed with modern techniques it can offer the following advantages :
— high performance and durability,
— available locally at lower cost,
— economic both in energy and foreign currency requirements,
— encourages the development of building trade skills.

Current developments in earth construction techniques cover a range which includes the most rudimentary, manual, artisan processes, as well as the most sophisticated, mechanized, industrial processes. At the higher end of this range, which has been the subject of an unprecedented level of scientific research, the production of materials in earth no longer suffers by comparison with that of other contemporary building materials, whatever their degree of sophistication. This trend towards industrialization became clear about 25 years ago in the production of compressed earth blocks. Earth technology thus no longer involves strictly artisan techniques with no potential for development. Evolution from artisan to industrial production is possible and real, but clearly this trend must be seen in the light of the specific parameters of any given situation : overall development policy, socio-economic and cultural aspects, economic and technological interdependence.

It is therefore particularly important to select equipment in accordance with these parameters and criteria, in order to optimize the matching of production apparatus to the given context.

CDI, Centre for the Development of Industry, recognizing the growing demand for information on the part of the ACP states on the one hand, and noting the wide range of production equipment available from the EEC states on the other hand, financed a critical study of European equipment available for use in ACP states. This study was prepared for internal use by CRATerre, International Centre for the Research and the Application of Earth Construction.

In view of the relevance of this confidential study and the appreciable lack of technical and scientific documentation concerning compressed earth blocks, CDI decided to publish a summary of the study, in the form of a guide to the selection of production equipment.
This guide is aimed essentially at national decision-makers, industrial groups and professional associations so that they can make their choices in full awareness of the facts, on the basis of a soundly-structured approach.
In this way, CDI hopes to contribute to the promotion of increased appreciation of this material among industrialists in the ACP states, and to encourage investment in industrial production units for compressed earth blocks.

It should not be forgotten, however, that the objective of setting up a brickworks is not just the production of building materials but, further down the line, the construction of appropriate housing, which is an infinitely more complex undertaking. At this level, information and training are as indispensable as they are unavoidable.

CDI, in compliance with its mandate, wants to participate actively in the exploration and the opening up of the new market offered by earth construction in a resolutely modern and industrial context.

CONTENTS

CHAPTER I
CONSTRUCTION IN EARTH

MAJOR TECHNIQUES

Amongst the traditional raw earth building practices, one can enumerate a vast number of construction techniques, with an infinite array of variants expressing their cultural and geographical origins. There are twelve principal well-known methods using earth as a building material. Amongst these, eight are currently employed and constitute the major techniques.

Adobe :
The earth, in a malleable state, often improved by the addition of straw or other fibres, is moulded into a brick form and dried in the sun. Originally, these bricks were shaped by hand. Later, and up until the present time, they are fabricated manually, but by means of wooden or metal parallelepiped moulds. These adobe bricks are now also machine processed.

Cob :
The earth, often improved by the addition of straw or other fibres, is shaped into big balls, which are piled on top of one another and lightly packed, by hand or foot, in order to erect shaped monolithic walls. In other cases, the cob is incorporated into a timber framework or structure.

Rammed earth :
The earth is dumped into formworks, compacted by means of a rammer, layer by layer, and formwork by formwork. Traditionally, this implement was made of wood. Today, pneumatic rammers or electrical vibrating tamping machines are used.

Wattle and daub :
Clayey earth, mixed with straw or other fibres, is layered on top of wattles that fill in a timber structure.

Straw clay :
The earth is spread out in water until a homogeneous thick liquid state is attained. This muddy liquid is mixed with straw so that a film is formed on every wisp. The building material obtained conserves its strawlike aspect. It is put into place by means of a formwork in order to erect a monolithic wall for which a primary support structure is needed.

Shaped earth :
The earth, often improved by the addition of straw or other fibres, is shaped into a wall using the same technique as that used for pottery, without tools. This ancient technique is still used on a widespread basis.

Extruded earth :
The earth is extruded by a powerful machine similar to, or derived from, the machines used for the manufacture of fired bricks.

Compressed earth
The earth is compressed, in block form, in a mould. In the past, the earth was compressed in the mould by means of a small pestle, or by tamping a very heavy lid energetically on the mould. Nowadays, a wide variety of presses is used.

CHAPTER II
THE COMPRESSED EARTH BLOCK

DESCRIPTION OF PRODUCT

The durability of earthen buildings, under normal conditions of use, is essentially dependent upon their stability in the face of aggressive elements (especially water) or under structural working constraints (resistance to compression, traction and shearing forces) whether in immediate or permanent loading mode.
The necessary stability is obtained by minimizing those potential aggressions and strains through architectural design features or by increasing the intrinsic qualities of the material used. In the latter case, the desired result is produced by two actions that eventually may be combined : the addition of an adjuvant and/or the compression of the particles that constitute the material. Compression is all the more easily attained when the smallest particles fill in the spaces left by the larger particles, with clay ensuring the cohesion of the material.

For small components, one of the ways in which compression is achieved is by using a press ; the product is known as the "compressed earth block".

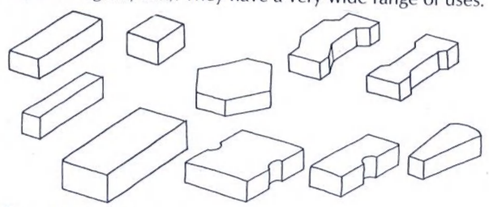
The compressed earth block may be stabilized. In this case the product is called a "stabilized compressed earth block".
Stabilization of the earth involves modifying the properties of the earth-water-air system in order to obtain permanent properties compatible with a particular application.
Compressed earth blocks are stabilized by adding a stabilizer to the earth. In most cases the stabilizer is a conventional binder such as cement or lime. The percentage by weight of these binders varies from 3 to 19 %, with a mean of 6 to 8 %.

These are some of the principal arguments in favour of compressed earth blocks :
— Well-adapted to local geological conditions and to a wide range of earth types.
— Low energy cost and minimum consumption of non-renewable resources.
— Employment of local human resources, through decentralization of production.
— Simplicity of production, minimum water consumption, ease of storage and low production cost.
— Less dependance on imported raw materials.
— High degree of adaptability to different contexts : rural, semi-urban, urban.
— Renewed emphasis on traditional local materials and preservation of traditions.
— Great architectural flexibility, and a wide variety of possible characteristics depending on the performance required (mechanical, static, hydrous, physical...).

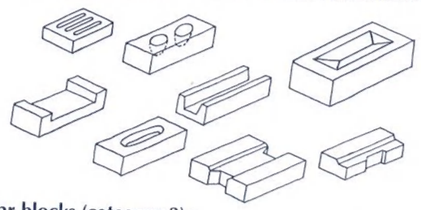
TYPES OF BLOCK

There are 4 categories of block :

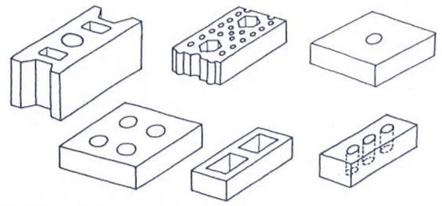
Solid blocks (category 1) :
Most solid blocks are prismatic in shape (parallelepipeds, cubes, multiple hexagons, etc.). They have a very wide range of uses.



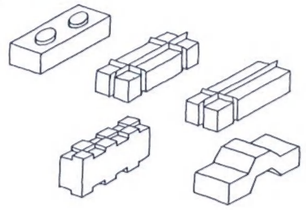
Hollowed blocks (category 2) :
These blocks usually have 5 to 10 % of the material removed, but this can reach 30 % with sophisticated procedures. The recesses improve the adhesion of the mortar and make the blocks lighter.



Alveolar blocks (category 3) :
The lightness of these blocks is an advantage, but they require fairly sophisticated moulds and higher compression pressures.



Interlocking blocks (category 4) :
These blocks can, in principle, be assembled without the use of mortar, but they require fairly sophisticated moulds and high compression pressures.



POSITION IN RELATION TO OTHER MATERIALS

A simplistic approach to the definition of the position of the compressed earth block in relation to other building materials is necessarily a false approach (e.g. comparing resistance to compression or production costs only). The question is a complex one.

When comparing material's it is important to do so for all stages of their existence, and for all processes they undergo during that existence ; the comparison should be made on the basis of all the aspects of the material's uses :

The main stages of existence are as follows :
— deposit,
— raw material,
— material,
— component,
— element,
— building,
— repair,
— waste.

The main processes are as follows :
— extraction,
— processing,
— manufacture,
— assembly,
— construction,
— use,
— deterioration.

The main aspects of use are :
— Technical aspects : mechanical, static, hydrous, physical, qualitative and other characteristics.
— Economic aspects : e.g. unit production cost, volume production cost, production cost by technical unit (e.g. cost per compression resistance unit), economic break-even level, capitalization, etc.
— Health aspects : emission of harmful gases or other chemical components, radiation, likelihood of harbouring disease-carrying insects, etc.
— Psychological aspects : nature of the material, surface texture, colour, shape, brightness, etc.
— Ecological aspects : deforestation, quarrying into hills, water consumption, energy consumption, generation of pollution, production of waste, etc.
— Social aspects : use of labour for manufacture and transport, cultural and social acceptability, etc.
— Institutional aspects : legislation, insurance, development policy, norms and standards, etc.

Clearly, only a well-planned feasibility study can produce this type of analysis, which carries great weight in the final choice.

However, a simple comparison of some of the important characteristics of the stabilized compressed earth block with those of other conventional construction materials is given in the table below :

COMPARISON OF CHARACTERISTICS

CHARACTERISTICS	SYMBOL	UNIT	STABILIZED COMPRESSED EARTH BLOCK	FIRED CLAY BRICK	CALCIUM SILICATE BLOCK	CONCRETE BLOCK
28 DAY WET COMPRESSIVE STRENGTH	Rc 28 wet	MPa	1 40	5 60	10 55	7 50
REVERSIBLE THERMAL EXPANSION		%	0.02 0.2	0 0.02	0.01 0.035	0.02 0.05
APPARENT BULK DENSITY	p	kg/m³	1 700 2 200	1 400 2 400	1 600 2 100	1 700 2 200
COEFFICIENT OF THERMAL CONDUCTIVITY	lambda	W/m°C	0.81 1.04	0.7 1.3	1.1 1.6	1 1.7
DURABILITY UNDER SEVERE NATURAL EXPOSURE			VERY GOOD TO LOW	EXCELLENT TO VERY LOW	GOOD TO MEDIUM	GOOD TO LOW
ENERGY INCORPORATED IN THE WALLS		MJ/kg	0.8 1.5	6	2.7	2.5
CEMENT OR LIME INCORPORATED IN THE BUILDING COMPONENT		% (weight)	6 8	0	12 19	12 14

From "Small-scale manufacture of stabilised soil blocks", SMITH R.G. and WEBB D.J.T., ILO, Geneva, 1987.

TECHNICAL PERFORMANCE

The technical performance of compressed earth blocks observed under real production conditions is extremely varied. Nevertheless, 4 major types of block may be defined on the basis of analysis of this performance. There is no direct relationship between these 4 types of block and their production conditions.

TECHNICAL PERFORMANCE OF COMPRESSED EARTH BLOCKS

MECHANICAL CHARACTERISTICS	SYMBOL	UNIT	COMPRESSED EARTH BLOCKS TYPE			
			1	2	3	4
28 DAY DRY COMPRESSIVE STRENGTH (+ 40 % after 1 year, + 50 % after 2 years)	Rc 28 dry	MPa	≃ 2	2 4	> 4	> 12
28 DAY WET COMPRESSIVE STRENGTH	Rc 28 wet	MPa	0.1 0.5	> 1	> 2	> 2
28 DAY DRY TENSILE STRENGTH (Brazilian test)	Rt 28 dry	MPa			1 2	
28 DAY DRY TENSILE STRENGTH (test on a core)	Rt 28 dry	MPa	0.5 1			
28 DAY DRY BENDING TEST	Rb 28 dry	MPa	0.5 1			
28 DAY DRY SHEAR TEST	Rs 28 dry	MPa	≃ 0.5			
POISSON'S RATIO	μ				0.15 0.35	
YOUNG'S MODULUS	E	MPa			700 7 000	
APPARENT BULK DENSITY	p	kg/m³	1 700 2 300	1 700 2 300	1 700 2 300	> 2 200
UNIFORMITY OF DIMENSIONS			GOOD	GOOD	EXCELLENT	EXCELLENT

NOTE : The absence of a value indicates that there is not enough relevant information.

TECHNICAL PERFORMANCE OF COMPRESSED EARTH BLOCKS

STATIC CHARACTERISTICS	SYMBOL	UNIT	COMPRESSED EARTH BLOCKS TYPE			
			1	2	3	4
RESISTANCE TO TANGENTIAL IMPACT BY A SOFT BODY (initial height of a 27 kg sandbag)		m			2 3	
RESISTANCE TO CRUSHING BY AN ECCENTRIC LOAD (reduction coef. for a 30 cm wall, h = 2.4 m)					> 0.5	> 0.5
BENDING STRENGTH (uniform horizontal pressure - wind)		MPa			5. 10 E-3 6. 10 E-3	
RESISTANCE TO LOCALIZED HORIZONTAL THRUST		N			> 4 500	
COEFFICIENT OF THERMAL EXPANSION		mm/m °C				

NOTE : The absence of a value indicates that there is not enough relevant information.

TECHNICAL PERFORMANCE OF COMPRESSED EARTH BLOCKS

HYDROUS CHARACTERISTICS	SYMBOL	UNIT	COMPRESSED EARTH BLOCKS TYPE			
			1	2	3	4
SWELL		mm/m				
POTENTIAL SHRINKAGE		mm/m				
SHRINKAGE DUE TO DRYING		mm/m	0.2 1		0.2 1	
PERMEABILITY		mm/s			1. 10 E-5	
WATER ABSORPTION THROUGH THE SURFACE TO BE COATED		% (weight)				
TOTAL ABSORPTION		kg/m³			10 20	0 7.5
SENSITIVITY TO FROST			HIGH	MEDIUM	LOW	NO
SENSITIVITY TO EFFLORESCENCE			NO	LOW	LOW	VERY LOW
DURABILITY UPON EXPOSURE TO WEATHER			VERY LOW	LOW	GOOD	EXCELLENT

NOTE : The absence of a value indicates that there is not enough relevant information.

TECHNICAL PERFORMANCE OF COMPRESSED EARTH BLOCKS

PHYSICAL CHARACTERISTICS	SYMBOL	UNIT	COMPRESSED EARTH BLOCKS TYPE			
			1	2	3	4
SPECIFIC HEAT	C	kJ/kg	≃ 0.85		0.65 0.85	
COEFFICIENT OF CONDUCTIVITY	lambda	W/m °C	0.81 0.93	0.81 0.93	0.81 0.93	0.93 1.04
DAMPING COEFFICIENT (40 cm wall)	m	%	5 10	5 10	5 10	5 10
LAG TIME COEFFICIENT (40 cm wall)	d	h	10 12	10 12	10 12	10 12
COEFFICIENT OF ACOUSTIC ATTENUATION (40 cm wall, frequency 500 Hz)		dB	50	50	50	50
COEFFICIENT OF ACOUSTIC ATTENUATION (20 cm wall, frequency 500 Hz)		dB	40	40	40	40
FIRE RESISTANCE			GOOD	GOOD	GOOD	GOOD
FLAMMABILITY						
SPEED OF FLAME SPREAD						

NOTE : The absence of a value indicates that there is not enough relevant information.

GENERAL SPECIFICATIONS

The compressed earth blocks produced until now were parallelepipeds with the following maximum dimensions :
— length : 40 cm (exceptionally 50),
— width : 20 cm (exceptionally 30),
— height : 20 cm.

Present-day blocks have the following nominal moulding dimensions :
— length : 29.50 cm,
— width : 14.00 cm,
— height : 9.00 cm.

These blocks are used here as reference for the general specification.

NOMINAL DIMENSIONS
— length : 29.50 cm,
— width : 14.00 cm,
— height : 9.00 cm.

DIMENSIONAL TOLERANCES
— length : + 1, - 3 mm,
— width : + 1, - 2 mm,
— height : + 2, - 1 mm.

SURFACE SMOOTHNESS
— Sides : the sweep must not exceed 1 mm.
— Compression surfaces : the sweep must not exceed 3 mm.

EDGE SMOOTHNESS
— The sweep must not exceed 2 mm.
— Some roughness of the edges is tolerated, as long as it is due to turning out and not due to faulty manipulation.

ROUGHNESS OF EXTERNAL SURFACES
— The external surfaces of blocks to be coated with mortar and the surfaces which disappear in the masonry should preferably be rough.
— The external surfaces of the blocks not to be coated must be smooth.

ALVEOLES, HOLES, PICK, SCRATCH
— Rough surfaces : must not exceed 15 % of the surface.
— Smooth surfaces : must not exceed 1 % of the surface.

DRY VOLUME MASS
— Dry :
minimum : 1 700 kg/m³ or 6.319 kg per block,
recommended : 2 000 kg/m³ or 7.434 kg per block.
— Freshly moulded :
minimum : 1 870 kg/m³ or 6.950 kg per block,
recommended : 2 200 kg/m³ or 8.177 kg per block.

NOMINAL VOLUME
— 3 717.00 cm³,
— 3.717 litres,
— 0.003717 m³.

SURFACES
— long side : 265.50 cm²,
— short side : 126.00 cm²,
— compression surface : 413.00 cm²,
— sides : 783.00 cm²,
— compression surfaces : 826.00 cm²,
— total surface : 1 609.00 cm².

OBLIQUENESS OF SURFACES
— The external surfaces may be slightly oblique, if the prescriptions of size, tolerance and form are respected.
— The inside surfaces of hollowed blocks should preferably be oblique.
— The interior spaces of hollowed or alveolar blocks may not have sharp corners.

LAMINATION, CLEAVAGES
These are not tolerated on any surface.

GAPS, CLEFTS, CRACKS, CREVICES
— Micro-cracks : micro-cracks could be tolerated on all surfaces.
— Macro-cracks :
— are tolerated only on non-exposed surfaces,
— their width and depth may not exceed 1 mm,
— their length must not exceed 10 mm, and their total quantity must not exceed, on average, one gap per 10 cm of edge, that is to say 21 mm.

CLIPPED EDGES
The width and depth of clipped edges must not exceed 10 mm.

RESISTANCE TO COMPRESSION WHEN DRY

For single- or two-storey buildings the downward force is about 0.1 to 0.2 MPa. There is therefore no point in employing materials capable of resisting a compression of 10 MPa or more.

Nevertheless, a compression resistance of 0.1 MPa is insufficient, because other stresses or loads are added to this single aspect of the performance of a solid compressed earth block and of a building constructed with this material. A safety factor of 20 or 30 is accepted at present in most situations in which this type of material is employed. A compression resistance of 2 to 2.4 MPa thus offers a wide safety margin which is now specified in most of the proposed standards and in the recommendations currently in force.

In calculating a value of dry compression resistance generally considered satisfactory for solid compressed earth blocks, the following parameters are taken into account :

— 1. Resistance required by the downward load :
— single- and two-storey buildings ..... 0.1 MPa

— 2. Safety factor ..... x 3
— variation in production quality,
— variation in execution quality,
— unintentional increase in overloads.

— 3. Reduction coefficient ..... x 4
— nature of material,
— resistance of mortar,
— thickness of wall,
— loading method.

— 4. Saturation coefficient ..... x 2
— dry resistance / wet resistance ratio.

TOTAL ..... x 24

which gives Rc 28 dry = 2.4 MPa,
equivalent to a dry compression resistance considered to be satisfactory.

The mean dry compression resistance of solid compressed earth blocks after curing for 28 days should be greater than 2.4 MPa, with no value less than 2 MPa.

It should also be noted that a dry compression resistance of 1.5 MPa is sufficient for the block to withstand transport by wheelbarrow or lorry.

The dry compression resistance of solid compressed earth blocks should be tested on 5 blocks of the same type.

The dry compression resistance of solid compressed earth blocks should be tested after drying for 28 days. The samples should be surfaced with pure paste at least 4 days before crushing.

RESISTANCE TO COMPRESSION WHEN WET

The mean wet compression resistance of solid compressed earth blocks after curing for 28 days (24 d. + 4 d. or 27 d. + 1 d.) should be greather than 1.2 MPa, with no value less than 1.0 MPa.

$$\frac{\text{mean Rc 28 wet}}{\text{mean Rc 28 dry}} \geqslant 0.5$$

The wet compression resistance of solid compressed earth blocks should be tested on 5 blocks of the same type.

The wet compression resistance of solid compressed earth blocks should be tested after curing for 24 days + 4 days of immersion. If this immersion is too severe, it is replaced by water absorption by capillary action for 24 hours. The procedure adopted is that used for the test of water absorption by capillary action. The wet compression resistance test should then be performed after curing for 27 days + 1 day of water absorption by capillary action. The samples should be surfaced with sulphur paste before crushing.

CONDITIONS OF USE

The conditions of use of compressed earth blocks depend essentially on the following parameters (provided that they are used in accordance with accepted practice) :
— climatic conditions,
— type of building,
— purpose of the building,
— building protection system,
— technical performance of the compressed earth blocks.

The complexity of the relationships between these parameters makes it impossible to compile a set of universally-applicable technical specifications for the construction of buildings using compressed earth blocks. However, the preparation of a document of this sort is recommended for each large project.

Nevertheless, it is possible to give an indication of the technical performance required for compressed earth blocks (type of block) as a function of the other parameters.

The minimum-standard block recommended for a given application is shown in the following table. The general indication of the recommended type of block is not absolute, and must be considered in the light of local conditions. It is important to note that where a precise indication (e.g. type 2) is shown for a given parameter, it refers to the general external walls of the building. There is nothing to prevent the use of other types of blocks in particular parts of the building (e.g. type 1 blocks for interior walls and type 3 blocks for the substructure).

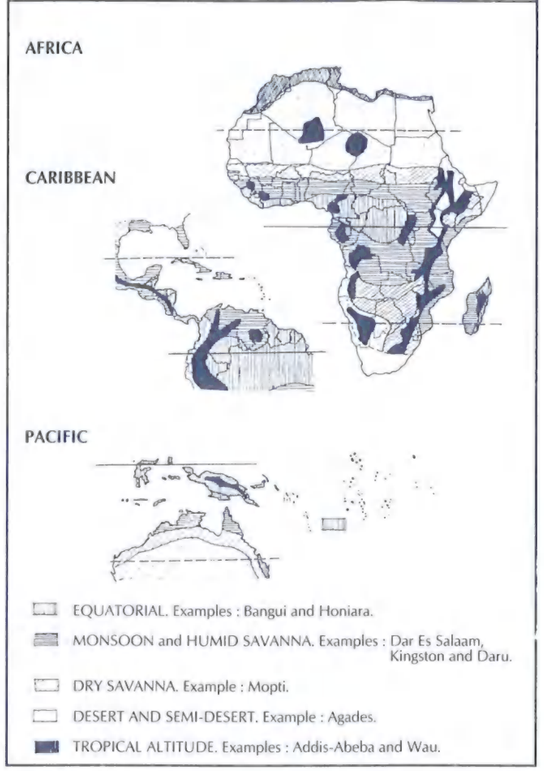
CONDITIONS OF USE OF COMPRESSED EARTH BLOCKS

BUILDING PROTECTION SYSTEMS	TYPE OF BUILDING	PURPOSE OF THE BUILDING	CLIMATIC CONDITIONS		
			TROPICAL HUMID	TROPICAL DRY	TROPICAL ALTITUDE
			BLOCK TYPE	BLOCK TYPE	BLOCK TYPE
TREATMENT OF THE BUILDING	SINGLE-STOREY	INDIVIDUAL	2	1	1
		COLLECTIVE	3	1	1
		PUBLIC	3	2	2
	MULTI-STOREY	INDIVIDUAL	3	1	2
		COLLECTIVE	3	2	2
		PUBLIC	3	3	3
TREATMENT OF SURFACES	SINGLE-STOREY	INDIVIDUAL	1	1	1
		COLLECTIVE	2	1	2
		PUBLIC	2	1	2
	MULTI-STOREY	INDIVIDUAL	3	1	2
		COLLECTIVE	3	2	2
		PUBLIC	3	3	3
TREATMENT OF THE MATERIAL	SINGLE-STOREY	INDIVIDUAL	3	2	2
		COLLECTIVE	3	2	3
		PUBLIC	3	3	3
	MULTI-STOREY	INDIVIDUAL	3	2	3
		COLLECTIVE	3	3	3
		PUBLIC	3	3	3

CLIMATIC CONDITIONS

The ACP countries are located in regions characterized by three main types of climate.

CLIMATIC MAP



TYPE OF BUILDING

Buildings can be divided into two types :

Single-storey buildings :
Minimum load stresses, low aerodynamic effects, low surface area exposed to bad weather.

Multi-storey buildings :
High load stresses, aerodynamic effects due to high exposure to wind, large surface area exposed to bad weather.

PURPOSE OF BUILDING

Three types of purpose are defined :

Individual use :
If the building is damaged, only one building, one family and one owner are involved. The damage, from the point of view of society in general, is limited and can be remedied on an individual basis.

Collective use :
Collective buildings and large projects involving individual buildings are included under this heading. If a design error leads to substantial damage the effect will be multiplied over a large number of buildings. Decisions must thus be much more securely based than in the first case.

Public use :
This might involve small or large buildings belonging to local, regional, or national authorities. In all cases utilization is intensive and the psychological influence is very important. Every possible measure must therefore be taken to ensure that the buildings (schools, health centres, administration...) remain in the best possible condition as they get older. Consideration of regular maintenance is essential.

BUILDING PROTECTION SYSTEM

Any earth wall must be able to resist humidity and the action of water. This resistance depends above all on the quality of the earth itself, on its texture, structure and porosity.

Resistance to attack by water can be improved by various systems of protection.

Protection by treatment of the building :
Architectural design and approach to construction : roof overhangs, canopies, substructure, etc.

Protection by treatment of surfaces :
Application of coatings : thick plaster, cladding, painting, etc.

Protection by treatment of the material :
Stabilization by additives in bulk material, by impregnation, or thin film coatings.

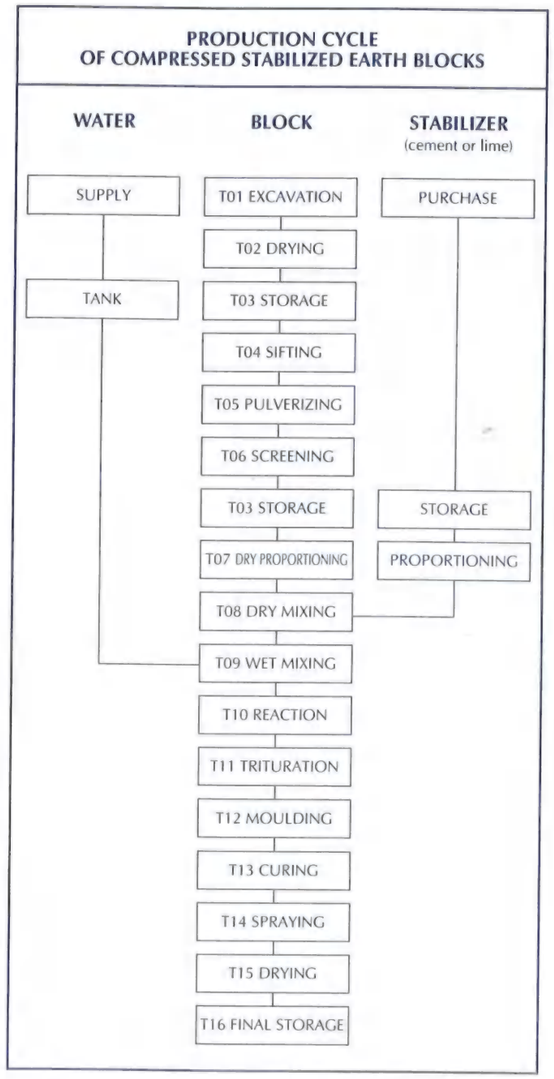
The use of one of these systems does not exclude the employment of the other systems.

TECHNICAL PERFORMANCE

4 types of block are defined :
— type 1,
— type 2,
— type 3,
— type 4.
To obtain more details, refer to "TECHNICAL PERFORMANCE".

PRODUCTION CYCLE

— T01 **EXCAVATION** of the soil from a borrow pit.
— T02 **DRYING** by spreading in thin layers or small ventilated heaps, or passing through a hot-air cyclone.
— T03 **STORAGE** of a reserve of raw or prepared soil at the work site.
— T04 **SIFTING** if the soil contains too many large stones, which have to be removed.
— T05 **PULVERIZING** to break up clayey aggregations.
— T06 **SCREENING** to eliminate undesirable elements after general preparation.
— T07 **DRY PROPORTIONING** of the earth by weight or by volume with a view to mixing it with water and/or stabilizer.
— T08 **DRY MIXING** to maximize the effectiveness of powder stabilizer.
— T09 **WET MIXING** to add water by spraying after dry mixing correctly, or directly in the form of a liquid stabilizer.
— T10 **REACTION** during variable hold-back time depending on the nature of the stabilizer ; very short for cement, longer for lime.
— T11 **TRITURATION** just before using the soil.
— T12 **MOULDING** final shaping of the earth.
— T13 **CURING** best carried out under the same conditions as for the early drying stage.
— T14 **SPRAYING** if necessary, to moisten the stabilizer properly.
— T15 **DRYING** for a sufficiently long period to ensure acceptable product quality.
— T16 **FINAL STORAGE** of products for immediate use.



CHAPTER III
PRODUCTION EQUIPMENT

PRESSES

THE TASK

In the case of the compressed earth technique, in its block form, the action of the presses consists precisely of compressing the particles. Compression is, of course, brought about by exerting pressure ; this seems simple, but depends upon very essential variables if it is to be effective.

TYPES OF EQUIPMENT

To obtain the definitions, refer to "TECHNICAL SELECTION CRITERIA".

Manual presses :
The compressing and turning out operations are carried out by machines which are operated manually.

Motorized pressed :
The compressing and turning out operations are carried out by motorized machines.

Mobile production units :
These production units are easily transportable. Not only compressing and turning out operations but also the preparation of the material and/or the emptying of the finished products, are motorized and eventually automated.

Fixed production units :
These production units are particularly difficult to transport. Not only compressing and turning out operations but also the preparation of the material and/or the emptying of the finished products, are motorized and sometimes automated.

SYSTEMS				CATEGORIES OF PRESSES	CHARACTERISTICS			
ENERGY SOURCE	SIZE	ENERGY TRANSMISSION	COMPRESSION		COMPRESSION PRESSURE	NET WEIGHT (kg)	THEORETICAL OUTPUT (blocks 29.5 x 14 x 9 per 8 hours)	PRICE RANGE (ECUs)
MANUAL	LIGHT	MECHANICAL	STATIC	**MANUAL PRESSES**	VERY LOW	50 to 100	300 to 800	400 to 2 500
		MECHANICAL and HYDRAULIC	STATIC		HYPER	50 to 150	300 to 400	2 500 to 5 000
	HEAVY	MECHANICAL	STATIC		LOW	200 to 500	400 to 1 000	1 000 to 3 000
MOTORIZED	LIGHT	MECHANICAL	STATIC	**MOTORIZED PRESSES**	LOW to MEDIUM	400 to 1 500	800 to 3 000	10 000 to 15 000
		HYDRAULIC	STATIC		LOW to MEDIUM	400 to 1 500	800 to 2 000	5 000 to 50 000
		MECHANICAL	STATIC	**MOBILE UNITS**	LOW to MEDIUM	1 500 to 2 000	800 to 3 000	10 000 to 20 000
		HYDRAULIC	STATIC		LOW to MEDIUM	2 000 to 4 000	800 to 3 000	25 000 to 85 000
	HEAVY	MECHANICAL	STATIC		LOW	4 000 to 6 000	2 000 to 15 000	50 000 to 85 000
		HYDRAULIC and MECHANICAL	STATIC or DYNAMIC		LOW to HYPER	3 000 to 6 000	1 500 to 7 500	60 000 to 150 000
		HYDRAULIC	STATIC	**FIXED UNITS**	LOW to MEGA	2 000 to 30 000	3 000 to 50 000	100 000 to 2 300 000
		HYDRAULIC and MECHANICAL	DYNAMIC			6 000 to 30 000	10 000 to 50 000	100 000 to 2 300 000

TECHNICAL SELECTION CRITERIA

The following list enumerates the essential points for which the manufacturer must have an answer when consulted. Certain criteria are more elaborate than others, either because they merit particular attention or because they are, generally speaking, not sufficiently taken into account.

Manufacturer's references :
The market for the production equipment is constantly evolving. Thus, it is not unusual to find that the address of a manufacturer or a retailer changes very frequently. It is therefore extremely difficult to evaluate the manufacturer's past history from simple knowledge of his current references.
Where possible, one should visit the manufacturer.
The complete manufacturer's references (name, address, telephone, telex, machine name, serial number...) must be engraved on a metallic plate riveted onto the machine.

Identification of the manufacturer :
It is important to know what type of manufacturer one is dealing with ; it is therefore essential to ask the manufacturer to specify the following points :
— past experience and history of the company,
— statutes of the company,
— business capital,
— professional qualifications certificate,
— number of employees in each service,
— manufacturer's own technical capacities,
— names of associates,
— names of the company's subcontractors,
— company's sales and distribution representatives.

References :
It is important to be aware of the stage of development of the proposed machine and to make enquiries amongst clients who already use it. One should require the manufacturer to specify the following aspects :
— number of machines produced,
— number of machines sold,
— number of machines in operation,
— number of orders or confirmed options to buy,
— clients' references.

One should know if the manufacturer has the necessary contact with his clients to obtain some feed-back from the sites, this should facilitate the introduction of improvements on the basis of production in the field.

Description of the products :
Certain machines can produce a complete range of building components (blocks, large and small paving tiles, roofing tiles...). For each of these products, one must request :
— denomination,
— geometrical description,
— schemes,
— photos.

Manufacturers often furnish reports of experimental tests or technical certificates concerning the products produced by their machines. One should check the validity of these documents carefully.

Dimensions of the block :
The dimensions of the most commonly used normal block are 29.5 x 14 x 9 cm (l x w x h) (length x width x height).
Two of these dimensions correspond to those of the mould employed ; the third dimensions, most often the height, depends upon the adjustment, often fine, of the machine, to the earth used. There exists a wide variety of other block dimensions, inspired by concrete blocks and fired brick equivalents.
For the typical block produced by a machine equipped with the most usual mould, one should request :
— complete dimension (l x w x h),
— tolerances,
— void radio (% of frogs and hollows),
— mean dry mass,
— geometrical description,
— schemes,
— photos.

One should be able to distinguish, from the dimensions or shape of the block, the way in which the block should be laid vertically (generally in the same direction as that of the compression during the block production). The block module must take into account apparatus problems due to traditional mortar joints (1 - 1.5 cm thick), to the joints necessary for the glue-mortar (several millimeters thick) or possibly to the absence of joints for the adhesive technique.
For a soil with a given moisture content, the presses never produce blocks whose dimensions and/or dry mass are perfectly constant. This is due to the irregularity of the filling up of the mould and to variations in the machine's operation (warming up...). A variation of less than 1 mm in the block height is good, 1 to 3 mm is average and more than 3 mm is mediocre.
For a static compression action by simple mechanical transmission, one is limited to a compression surface area of approximately 500 cm^2 and to 10 cm in height.

If the dimensions of the block are too big, handling is difficult because of the excessive weight.
The multi-purpose machines also allow for a finished product measuring from 1.5 to 2 cm in height. This is particularly suitable, for example, for the manufacturing of roofing and paving tiles.

Dimensions of other products :
For the other finished products, one should request :
— complete dimensions (l x w x h),
— tolerances,
— void ratio (% of frogs and hollows),
— mean dry mass,
— geometrical description,
— schemes,
— photos.

Appearence of the blocks :
Certain compression and turning out devices leave the exposed surfaces of the product smooth, other devices leave them in a rough condition. One or other of these solutions will be advantageous depending upon the final use of the product. If the surfaces of the blocks that are to be covered with mortar or coating are too smooth, the adhesion process between the block and the mortar is made more difficult.

Hollowing out :
It is useful to be able to produce blocks with hollows of tall kinds (frogs, partial perforation or totally hollowed out from one side to the other). The volume hollowed out is generally limited to about 30 % (void ratio) of the total product volume, in the case of the most efficient machines. The granular quality of the earth must be adapted to the thickness of the partition or side panels of the blocks in order to avoid mechanical weaknesses and maintain the product's correct appearance.

Denomination of the machine :
One sometimes finds machines on the market that are very similar but differ in designation either within the range of one manufacturer's products or from one manufacturer to another. In the first instance, the different denominations correspond to the manufacture of the same machine built at different periods of time. In the second case, one probably has to deal with more or less successful copies of a machine that was or is commercially successful (differences in quality of raw materials used, tolerances of the dimensions, reliability...) or, on the contrary, a machine that had been a total failure. These denominations could also be attributed to the manufacturing of a machine under licence. One must thus distinguish between :
— exact denomination of the machine,
— common denomination,
— commercial denomination of the machine.

Historical background of the machine :
If the manufacturer cites a patent, one should not confuse "patent" with "patent pending". A patent is not necessarily a proof of guaranteed quality. Manufacturers frequently apply for patents for processes that are already of the public domain. Their application is not always rejected by the competent body. One runs the risk of paying for the right to exploit a patent which is unjustifiable.

Description of the machine :
One must obtain from the supplier a brief description of the press and other elements of the production unit, where applicable, as well as its working operation.

Photos taken from every angle :
These photos are necessary, both to prove that the machine really exists and to back up the salesman's presentation of the machine.

Degree of integration :
In the case of mobile and fixed production units, which have integrated devices for the preparation of the earth and/or the emptying of the products, one should check that the production unit provides for simultaneous or alternative operation (only one action at a time) and whether the elementary rules of production (supplying, correct proportioning, mixing time...) are respected by the different devices employed (sieve, conveyor belt, mixer, hopper...) which must have homogeneous capacities.
One should refer to the technical selection criteria for the other production equipment presented in this document.

Degree of automation :
Certain machines can execute all or a part of the production automatically. Generally, it is the filling, compression and turning out cycle which is automatic. One must be able to disengage the automatic system in order to check the working order of the machine or to make adjustments. The automatic control system should allow for the adjustment of the production rate.
The reliability of the control systems, whether mechanical or electronic, must be carefully checked. One must be aware of the fact that sophisticated control devices often necessitate specific training and experience in order to maintain, repair or replace them.

Method of moving :
The machines may be fitted with wheels and moved manually or mounted on a chassis and towed by a vehicle adapted to the load. Large wheels with pneumatic tyres are better than small wheels without pneumatic tyre.

Working encumbrances :
This criterion influences appreciably the organization of the production area.

Transport encumbrances :
This criterion greatly influences the cost of transportation of the machine.

Net weight :
A particularly heavy machine will not be able to be moved, even a few meters, without recourse to a suitable lifting device.

Packaged weight :
This criterion greatly influences the cost of transporting the machine.

Energy source :
In order to operate the presses, a source of human energy (manual presses) or mechanical energy (thermal or electrical motor presses) is required.

Manual presses : the force exerted by one or several workers depends principally upon their weight but also upon their stamina and the attention they pay to their work. There are regularly notable variations in the quality of the final product especially after several hours of work.

Motorized presses : motorization helps to overcome the problem of human fatigue associated with the utilization of the manual presses, and can increase the force exerted, by means of more compact transmission mechanisms.
Where possible, it is advisable to provide for oversized motors, capable of functioning in tropical weather conditions, if necessary, chosen from a range of motors that is locally available, including spare parts, repair and maintenance service. When dealing with mobile or fixed units, the use of one common source of energy, to feed the different sub-units, creates an interdependency, which can cause a lot of complications and make access to the fault difficult in the event of a mechanical breakdown.

Energy transmission :
Energy can be transmitted to the different mechanisms and to the earth by means of levers, pivots, connecting rods or ball and socket joints, pistons, etc. There are two principal groups of energy transmission systems : mechanical and hydraulic systems.

Mechanical systems : these systems are generally speaking simple and heavy, unless one has recourse to special alloys. In this latter case, it is often difficult to repair the machine, in every context, in the event of a mechanical breakdown.

Hydraulic systems : these machines are more complex and generally more susceptible to environmental influences, particularly to air containing dust or sand particles (the immersed pumps are the most efficiently protected) and to elevated temperatures.
The fact that most of the spare parts fitted to the hydraulic systems are designed for normal functioning at temperatures of about 70° C, obliges manufacturers either to equip the machines with cooling mechanisms for the hydraulic fluid and/or to oversize tank capacity, or to employ parts and hydraulic fluid that can resist up to 120° C or more, or even to diminish the fluid pressure. The phenomena associated with the overheating of the hydraulic fluids are the most susceptible in tropical climates. To ensure adequate functioning of an hydraulic system at extremely elevated temperatures, one must always provide for supplementary expenditure in comparison to the original basic machine.
The pressure used to service the hydraulic fluid must be as low as possible and yet still compatible with the desired compression pressure in order to avoid overloading the pipes and overheating. The maintenance cost is often more important than foreseen and the supply of spare-parts creates enormous constraints when dealing with outlying areas. Therefore a standardization of the spare parts that are most sensitive to wear (flexible tubing, joints...) is highly desirable.

Energy consumption :
Energy comsumption must be taken into account, particularly when dealing with supply problems.

Hydraulic fluid consumption :
Supplying hydraulic fluid is often difficult and costly. The fluid change devices must be carefully designed in order to prevent the introduction of dust or sand particles, for example.

Compression :
Compression is carried out either by static means, by dynamic means (impact or vibration), or a combination of several of these types of processes. Until the present time, the static compression method has been the most commonly used, sometimes accompanied by one of the dynamic means. The dynamic compression process permits a certain amount of enlargement of the dimensions compressed, which are more limited when only a static compression is applied. However, the compression cycle is long and there are heavy demands on the mould. Dynamic compression by means of vibration requires a motorized system.

Available force :
This refers to the force potentially available to compress the earth, which one can use as desired : applied to a small or large surface area, for example.
This parameter does not refer to the performance of a particular press, but enables one to situate the press in the range of available presses.

Compression pressure :
The pressure needed for the compression process enables one to assess the potential of the press. It is the pressure which is theoretically applied to the earth and which expresses the relation between the available force and the area over which that force is applied (one or several blocks).
The following is the classification generally adopted :

— very low pressure	:	0.5 to 2 MPa
— low pressure	:	2 to 4 MPa
— medium pressure	:	4 to 6 MPa
— high pressure	:	6 to 10 MPa
— hyper pressure	:	10 to 20 MPa
— mega pressure	:	20 to 40 MPa (or more).

Available pressure at the end of compression :
This is the pressure that really gets transmitted to the earth at the end of the compression cycle. This parameter is extremely difficult to measure. The pressure at the end of compression incorporates all the pressure losses due to the effects of the operation of the machine, friction and inertia. In the case of the mechanical energy transmission machines, this pressure is definitely inferior to that of the compression pressure. For example, the available pressure at the end of compression for a small hand lever press is from 1.5 to 2 MPa, under the best of operating conditions, whereas the documentation refers to a compression pressure of 4.5 MPa (pressure theoretically applied to the earth).
As far as the hydraulic transmission energy machines are concerned, the available pressure at the end of compression is essentially the same ($\simeq -5$ %) as that cited for the compression pressure. However, the available pressure at the end of compression will drop if the hydraulic fluid becomes overheated. It is the pressure at the end of compression which is generally referred to in the production specifications. If the values of the pressure at the end of compression are given by the manufacturer, one should check the measurement procedure.
The block resistance to crushing and moisture is almost directly proportional to the pressure at the end of compression up to a certain critical point, which is often situated between 4 and 10 MPa, after which it becomes asymptotic and, in certain instances, begins to fall off. Excessive moulding pressure (often more than 10 MPa) can, in effect, have harmful consequences, especially if attained too rapidly and if the earth is fine grained. This produces lamination, fissuring and swelling. It is advisable to be able to limit the pressure at the end of compression, by adjusting, to ensure the best possible adaptation of the press to the properties of the earth used.
The regular aspect of the finished product depends not only upon the pressure applied at the end of compression, but more especially upon the choice of earth used.

Dynamic effect coefficient :
For the static compression presses, there exists a dynamic effect due to the inertia of the machine, which benefits from this effect once it is started up. One thus applies a dynamic coefficient effect, for a manual press, of about 1.2 which increases the value of the pressure at the end of compression.

Compression mode :
Friction forces, which develop along the surfaces of the mould and inside the earth, diminish the pressure at the end of compression. This leads to variations in the dry volume mass and consequently, to variations in the mechanical characteristics of the blocks, depending upon their height. For a pressure at the end of compression lower than 6 MPa, this effect is negligible if the height of the block is less than 7 cm, small if the block is from 7 to 12 cm high, medium if the block is from 12 to 15 cm high and considerable if the height of the block is higher than 15 cm. When applying simple static compression, the height of the blocks, of acceptable quality, is generally limited to a maximum of 10 cm.
When using a double compression mode, which applies pressure simultaneously on two opposite sides of the mould, blocks of about 20 cm in height can be produced. The earth which is the least compressed is situated in the zone the least subject to handling stresses, i.e. the central part of the block. In order to be really efficient, the pressure applied must be the same on both sides of the block and must not be released, even for an instant.
If applying dynamic compression pressure, one can eventually produce blocks of this same height, but without the double compression action.

Compression ratio :
In theory the compression ratio is the ratio of the volume of uncompacted earth placed in the mould to the volume of the earth after compression.
In general the length and width of the volume occupied by the earth remain constant, and only the height varies.
The mould should preferably be designed to contain the exact volume of earth required for the manufacture of the block.
In practice the compression ratio is thus defined by the ratio of the depths of the mould before and after compression. For blocks of about 10 cm in height the compression ratio should preferably be at least 1.65. The ideal value is close to 2, but this figure is rarely achieved.
The compression ratio value can be inaccurate if excessive mould depth means that the mould is never completely filled. Manual or mechanical pre-compacting using a hinged lid can compensate for a moderate compression ratio.
One should be able to adjust the compression ratio, either by adjusting the depth of the mould and/or modifying the stroke of the piston, in order to ensure a perfect adaptation to the type of earth used and its optimum moisture content. Problems often occur when dealing with mechanical energy transmission machines, whereas the adjustment of hydraulic energy transmission machines is generally easy. In the case of a dynamic compression action, the compression ratio can be different.
The uncompacted earth, placed in the mould has a dry volume mass which varies from 1 000 to 1 400 kg/m³. Compressed, the earth must attain a minimum dry volume mass of 1 700 kg/m³ and can attain 2 300 kg/m³, depending on the type of earth used.

Compression speed :
Production imperatives can impose high production rates. It must be noted, however, that the length of the shortest compression cycle is about 1 to 2 seconds for blocks 10 cm high, without risk of lamination. If the compression process is too rapid or if the applied compression pressure is very high, the compression cycle must be interrupted after completion of the pre-compression phase, in order to allow the trapped air to escape. The final compression phase can then be carried on, but at a much slower pace. The higher the compression pressure and the lower the operating clearance between the piston and the mould, the more critical the compression speed becomes.

Vibration frequency :
For presses with mixed compression action, dynamic compression by vibration and static compression, the vibration frequency of the vibrating table is about 50 Hz.

Vibration amplitude :
For presses with mixed compression action, dynamic compression by vibration and static compression, the vibration amplitude of the vibrating table is several millimeters and should be adjustable.

Mechanism for filling up the mould :
There are two main types of filling methods : filling up the mould by proportioning the earth by volume (the most current process and the easier of the two methods) and filling up the mould by proportioning the earth by mass (a more precise technique but much more difficult to carry out).
The filling process can be done manually or automatically either by using a fixed hopper or a drawer-mould.
For rotating or drawer-moulds, which only pass once under a fixed hopper, the problem of homogeneous filling arises. One part of the mould fills up more than the other. During compression, when the upper side of the block is not parallel to the lower side of the block, the result is an irremediable distortion of the compression mechanism.
The problem of homogeneous and constant filling up of the mould is even more acute when several moulds are simultaneously filled.
In order to be efficient, the filling systems by hopper must not be too sensitive to the quantity of earth present in the hopper, its state of expansion and moisture content. Some manufacturers provide a device to check if there is enough earth in the hopper or not.
If the loading of the hopper is placed too high, a mechanical filling device must be provided.

Compression mechanism :
There are several types of moulds : fixed moulds, rotating moulds (rotating tables) with or without bottoms and conveyor moulds (drawer-moulds).
There are also several ways of displacing the compression piston : vertical displacement (upward or downward movement) and horizontal displacement.
In all cases, the mechanism which guides the piston movement must ensure its perfect alignment during the complete stroke.
The two compression planes (the surface of the piston or pistons, that of the lid and the support surface) must stay perfectly parallel one to another.
The sides of the moulds must be largely oversized and reinforced in order to avoid any deformation in time.
Manufacturers sometimes coat the mould surface and the compression pistons. This is only useful when treating exceptional earths of volcanic origin, for example. The coats will quickly disappear if abrasive earth is used. Generally speaking, if any adherence problems occur during the first few days of operation, the polishing of these surfaces, caused by the earth, which is very abrasive, rapidly resolves this problem.
One should check the compression mechanism to establish whether it allows for the installation of hollowing devices.
The clearance between the compression plans (piston) and the mould must be sufficient, so as not to trap the air during the compression cycle.

Monitoring devices at the end of the compression cycle :
The devices used at the end of the compression cycle can be gauged on the displacement effected, which is generally the case for the mechanical energy transmission presses, or on the available pressure at the end of compression, which is more commonly the case for hydraulic energy transmission presses.
The action of this device, which must be easily adjustable, has a notable influence on the dry volume mass of the block. For certain types of earth, a 5 % variation of the dry volume mass of the block can lead to a 30 to 50 % decrease in its resistance to crushing.
In practice, in order to avoid an untimely blockage of the compression device or too wide a variation of the product dimensions, certain manufacturers use compensatory mechanisms (springs, valves, torque limitors...) which means that one cannot always categorize the machines according to the above-mentioned types i.e. constant displacement or constant pressure at the end of the compression cycle.
In the event of blockage, it is preferable that the machine does not necessitate the dismantling of the mould in order to evacuate the block or the manual removal of the block from inside the mould. It is advisable that the cycle be able to continue, in spite of this problem and that the unacceptable block be discarded by the operator at the end of the cycle.

Maximum piston stroke :
Refer to "Dimensions of the block" and "Compression ratio".

Maximum mould depth :
Refer to "Dimensions of the block" and "Compression ratio".

Number of moulds per table :
The more numerous the number of moulds per table, the more onerous the changing of the block or product module.

Turning out mechanisms :
There are two types of piston movement for the turning out process : vertical displacement (either in the direction of the applied compression pressure or in the opposite direction) and horizontal displacement (in the sense of the applied compression pressure or in the direction perpendicular to that of the applied compression pressure).
In every case, the turning out device must not create constraints for the final product which remains, in any event, sensitive to shocks and shearing. The defects produced by the turning out device are often difficult to discern initially, with the naked eye.
Certain mechanisms do not permit the starting up of a new production cycle as long as the block has not been removed, which avoids the destruction of the subsequent blocks or a breakdown of the machine. In the case of the turning out devices that are horizontally displaced, the machine must be equipped with a buffer lay-out in order to permit the storage of a few blocks.
One should check the turning out mechanism to establish whether it allows for the installation of hollowing devices.
On the machine, a buffer stage to store some blocks is useful.

Length of the filling, compression and turning out cycle :
The most efficient manual presses run a cycle from 30 to 60 s.
For motorized presses requiring human intervention, it is difficult to run a cycle in less than 15 s for the complete filling, compression (1 to 2 s minimum) and turning out cycle.
In the best of cases, the automatic production units can run this same cycle in about 7 or 8 s.

Theoretically, a 15 s cycle, for example, should permit the completion of 2 000 compression cycles during an 8 hour working day. If the compression actions are more complex (double compression, alternative compression in two movements, dynamic compression), the length of this cycle is increased. Manufacturers, therefore, provide for the production of several blocks per cycle, in order to increase the output.

Number of blocks produced per cycle :
Refer to "Length of the filling, compression and turning out cycle".

Output :
The theoretical output of the machines corresponds to the total number of filling, compression and turning out cycles per hour multiplied by the number of blocks produced per cycle.
The practical output corresponds to the theoretical output minus the time estimated for periods of inactivity, principally allocated to routine machine maintenance.
The real output in the field is different again. It depends upon a number of incidents that are totally unrelated to the machine, such as production organization, supply management... The real output is often less than half the commercial claims.

Number of workers needed to operate the machine :
This figure must be the result of experience acquired in the field and not just a theoretical figure based on the degree of automation of the machine. One should distinguish the personnel needed to operate the machine, from those responsible for the handling of the raw materials and the finished products. The level of qualification must be determined for all personnel.

Security devices :
Special attention must be given to ergonomic utilization, to the passive security of the workers and to the immediate surroundings as well as to the security mechanisms of the machine itself (thermal fuses, security pins, circuit-breakers...)
The machine must, imperatively, be equipped with an emergency stop switch which is readily accessible.

Factory price :
One should be careful of speculation. Certain machines are sold at several times their price depending upon the retailer, sometimes as much as ten times more expensive than other machines which have the same performance. Certain machines, on the other hand, cost the same but clearly have much lower performance.
It is necessary to provide for depreciation cost in the production budget.
One should ask the manufacturer to detail every item and not to write formulas such as "including...". In this way, one can compare proposals.

FOB price :
The FOB price (Free On Board) includes packaging, transport and insurance of the equipment up to the border of the country in which the machine is manufactured, or onto ships. This price is often artificially inflated in order to compensate for the reduction offered on the factory price.

Sales or rental conditions :
One should ensure the viability of contracts indexed on the quantity of products produced or the payment of royalties for the right to exploit a patent, which sometimes may not even exist.

Delivery delays :
The contract must provide for a penalty clause if the delivery delays are not respected. Sometimes the delivery delays are very long due to the fact that the machines only exist on paper.

Conformity certificates :
For sophisticated machines, one must insist upon the delivery of a certificate stipulating that the equipment conforms to the norms applicable in the country where the machine will be put into operation.

Operator's manual :
This must be delivered with the machine and explain fully its operation, the required adjustments for production and the general maintenance. It does not serve as substitute for the technical manual for important maintenance operations and the repairing of the machine.

Installation contract :
The fixed production units must be installed on the production site, by competent technicians who will also be responsible for making the adjustments necessary for effective production. Certain manufacturers propose installation plans for the production lay-out which are determined by the features of the machine (feeding, emptying and products storage).
In addition, the installation technicians should be able to demonstrate earth selection, choice of stabilizer, mixing methods, block production and curing.

After sales service contract :
The after sales service contract must clearly stipulate the waiting period provided for repairs and maintenance.

Maintenance
Particular attention must be paid to this criterion. One must request a maintenance program (indicating the operations necessary and the expected maintenance frequency) and a technical manual, in which must figure all the diagrams (hydraulic, electric, electronics...) required for a good understanding of the working machine and the origin of breakdowns. The technical manual should list the original spare parts and give their exact references.

Training contract :
Training may concern the operation and maintenance of the machine, the production technique or the more general earth construction technique. The objectives of this training, as well as the type of personnel expected to undergo this training, must be clearly defined.

Feasibility study :
Some manufacturers offer to carry out feasibility studies for their potential clients on compressed earth blocks production or even building construction using these materials. It is more advisable, for such studies, to commission competent and objective professionals rather than manufacturers.

Options :
One should request the descriptions of the available options, their performance, cost and the compatibility of these various options in relation to one another and in relation to the existing equipment.

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC

Equipment featured in this inventory is limited to items manufactured in the EEC and marketed by commercial enterprises which replied to a questionnaire they were sent in 1987.

Note :
Equipment prices are given for guidance only (valid January 1988) and have no contractual significance.

All characteristics cited refer to the typical block produced by the machine, unless otherwise specified.

Categories of blocks :
1 : Solid blocks
2 : Hollowed blocks
3 : Alveolar blocks
4 : Interlocking blocks
Other : Other building components
( ) : On request.

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC : SUMMARY TABLE

MACHINE	DISTRIBUTOR	COUNTRY	PRICE (ECUs)	TYPE	PRACTICAL OUTPUT (m^3/day)	CATEGORIES OF BLOCK
BREPAK	MULTIBLOC	UNITED KINGDOM	1 800	MANUAL PRESS	1.3	1, (2), (3)
CERAMAN	CERATEC	BELGIUM	1 770	MANUAL PRESS	2.7	1, 2, OTHER
CERAMATIC	CERATEC	BELGIUM	16 700	MOTORIZED PRESS	9	1, (2)
DSH	LA MÉCANIQUE RÉGIONALE	FRANCE	10 700	MOTORIZED PRESS	5.6	1
DSM	LA MÉCANIQUE RÉGIONALE	FRANCE	745	MANUAL PRESS	3.2 - 3.9	1
DYNATERRE 01-4M	RAFFIN	FRANCE	69 000	MOBILE UNIT	26.9	1, 2, 3, OTHER
GÉO 50	ALTECH	FRANCE	860	MANUAL PRESS	2.7 - 3.3	1
PACT 500	ALTECH	FRANCE	11 400	MOTORIZED PRESS	8.6	1
PRESS-BLOC 80 TM	GÉOBETON ONE	FRANCE	75 000	MOBILE UNIT	9.4	1, (2)
SEMI-TERSTAMATIQUE	APPRO-TECHNO	BELGIUM	8 400	MOTORIZED PRESS	5.9	1, 2, OTHER
TEROC T2A	SARET	FRANCE	143 000	FIXED UNIT	16.4	1, 2
TERSTARAM	APPRO-TECHNO	BELGIUM	1300	MANUAL PRESS	2.7	1, 2, OTHER
TMR 6750-40	RGF TERRE 2000	FRANCE	57 700	FIXED UNIT	17.3	1
UNATA 1003	UNATA	BELGIUM	375	MANUAL PRESS	2	1

The above presses are described in detail on the following (pages 18-30).
This is followed by a description of additional presses under "OTHER DEVELOPMENTS" (pages 31-32).
This, in turn, is followed by description of pulverizing, sieving and mixing equipment.

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC : MANUAL PRESSES

DISTRIBUTOR	ALTECH	APPRO-TECHNO	CERATEC
MANUFACTURER	ALTECH	PLATBROOD F.	CERATEC
COUNTRY	FRANCE	BELGIUM	BELGIUM
DENOMINATION	GÉO 50	TERSTARAM	CERAMAN
DEGREE OF INTEGRATION	PRESS	PRESS	PRESS
METHOD OF MOVING	PORTERAGE	HAULAGE	HAULAGE
WORKING ENCUMBRANCES (l x w x h)	2.50 x 0.35 x 1.00 m (without stabilizing device)	1.35 x 0.70 x 0.90 m	1.40 x 0.50 x 1.00 m
TRANSPORTATION ENCUMBRANCES (l x w x h)	0.40 x 0.35 x 1.00 m	1.50 x 0.55 x 1.02 m	1.49 x 0.66 x 1.17 m
NET WEIGHT	125 kg	380 kg	350 kg
PACKAGED WEIGHT	160 kg	520 kg	500 kg
ENERGY SOURCE	HUMAN	HUMAN	HUMAN
ENERGY TRANSMISSION	MECHANICAL BY LEVER	MECHANICAL BY LEVER	MECHANICAL BY LEVER
ENERGY CONSUMPTION	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
HYDRAULIC FLUID CONSUMPTION	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
COMPRESSION	STATIC	STATIC	STATIC
AVAILABLE FORCE	100 kN	150 kN	85 kN
COMPRESSION PRESSURE	2.4 MPa	3.6 MPa	2.0 MPa
AVAILABLE PRESSURE AT THE END OF COMPRESSION	NOT COMMUNICATED	NOT COMMUNICATED	NOT COMMUNICATED
DYNAMIC EFFECT COEFFICIENT	1.2	1.2	1.2
COMPRESSION MODE	DOUBLE	SIMPLE	SIMPLE
COMPRESSION RATIO	1.78	1.42 (+ folding back lid)	1.50 (+ folding back lid)
COMPRESSION SPEED	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
VIBRATION FREQUENCY	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
VIBRATION AMPLITUDE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
MECHANISM FOR FILLING UP THE MOULD	NONE	NONE	NONE
COMPRESSION MECHANISM	VERTICAL STROKE PISTON AND SUSPENDED MECHANISM	VERTICAL STROKE PISTON AND FOLDING BACK LID	VERTICAL STROKE PISTON AND FOLDING BACK LID
PISTON STROKE	70 mm	38 mm	45 mm
MOULD DEPTH	160 mm	143 mm	140 mm
No OF MOULDS / TABLE	1	1	1
TURNING OUT MECHANISM	VERTICAL STROKE PISTON	VERTICAL STROKE PISTON	VERTICAL STROKE PISTON
LENGTH OF CYCLE	20 - 24 s	24 s	24 s
No OF BLOCKS / CYCLE	1	1 (or 2 small sized)	1 (or 2 small sized)
THEORETICAL OUTPUT	150 - 180 blocks/hour	150 blocks/hour	150 blocks/hour
PRACTICAL OUTPUT	90 - 110 blocks/hour 2.7 - 3.3 m^3/8 hours	90 blocks/hour 2.7 m^3/8 hours	90 blocks/hour 2.7 m^3/8 hours
CATEGORIES OF BLOCK	1	1, 2, other components	1, 2, other components
DIMENSION OF BLOCKS	29.5 x 14.0 x 9.0 cm	29.5 x 14.0 x 9.0 cm	29.5 x 14.0 x 9.0 cm
No OF WORKERS NEEDED	2	3	3
FACTORY PRICE	860 ECUs	1 300 ECUs	1 770 ECUs
FOB PRICE	NOT COMMUNICATED	NOT COMMUNICATED	NOT COMMUNICATED
OPTIONS	NONE	MANY MOULDS	MANY MOULDS
TRAINING CONTRACT	POSSIBLE	POSSIBLE	POSSIBLE

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC : MANUAL PRESSES (continued)

DISTRIBUTOR	LA MÉCANIQUE RÉGIONALE	MULTIBLOC	UNATA
MANUFACTURER	LA MÉCANIQUE RÉGIONALE	MULTIBLOC	UNATA
COUNTRY	FRANCE	UNITED KINGDOM	BELGIUM
DENOMINATION	DSM	BREPAK	1003
DEGREE OF INTEGRATION	PRESS	PRESS	PRESS
METHOD OF MOVING	PORTERAGE	PORTERAGE	PORTERAGE
WORKING ENCUMBRANCES (l x w x h)	1.79 x 0.28 x 0.82 m (without stabilizing device)	2.29 x 0.51 x 0.76 m (without stabilizing device)	2.25 x 0.26 x 0.70 m (without stabilizing device)
TRANSPORTATION ENCUMBRANCES (l x w x h)	0.55 x 0.35 x 0.95 m	0.84 x 0.62 x 0.92 m	0.49 x 0.31 x 0.95 m
NET WEIGHT	85 kg	172 kg	85 kg
PACKAGED WEIGHT	110 kg	180 kg	100 kg
ENERGY SOURCE	HUMAN	HUMAN	HUMAN
ENERGY TRANSMISSION	MECHANICAL BY LEVER	MECHANICAL BY LEVER AND HYDRAULIC BY MANUAL JACK	MECHANICAL BY LEVER
ENERGY CONSUMPTION	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
HYDRAULIC FLUID CONSUMPTION	NOT APPLICABLE	0.7 l RESERVOIR	NOT APPLICABLE
COMPRESSION	STATIC	STATIC	STATIC
AVAILABLE FORCE	120 kN	440 kN	100 kN
COMPRESSION PRESSURE	2.8 MPa	10.8 MPa	2.5 MPa
AVAILABLE PRESSURE AT THE END OF COMPRESSION	NOT COMMUNICATED	10.8 MPa	NOT COMMUNICATED
DYNAMIC EFFECT COEFFICIENT	1.2	1.0	1.2
COMPRESSION MODE	DOUBLE	SIMPLE	SIMPLE
COMPRESSION RATIO	1.57	1.55 - 1.94	1.55
COMPRESSION SPEED	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
VIBRATION FREQUENCY	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
VIBRATION AMPLITUDE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
MECHANISM FOR FILLING UP THE MOULD	NONE	NONE	NONE
COMPRESSION MECHANISM	VERTICAL STROKE PISTON AND ECCENTRIC MECHANISM	VERTICAL STROKE PISTON AND HYDRAULIC JACK	VERTICAL STROKE PISTON
PISTON STROKE	NOT COMMUNICATED	respectiv. 35 mm and 20 mm	50 mm
MOULD DEPTH	165 mm	155 mm	140 mm
No OF MOULDS / TABLE	1	1	1
TURNING OUT MECHANISM	VERTICAL STROKE PISTON	VERTICAL STROKE PISTON	VERTICAL STROKE PISTON
LENGTH OF CYCLE	20 - 24 s	60 s	30 s
No OF BLOCKS / CYCLE	1	1	1
THEORETICAL OUTPUT	150 - 180 blocks/hour	60 blocks/hour	120 blocks/hour
PRACTICAL OUTPUT	90 - 110 blocks/hour 3.2 - 3.9 m^3/8 hours	40 blocks/hour 1.3 m^3/8 hours	70 blocks/hour 2.0 m^3/8 hours
CATEGORIES OF BLOCK	1	1 (2, 3 on request)	1
DIMENSION OF BLOCKS	29.0 x 14.5 x 10.5 cm	29.0 x 14.0 x 10.0 cm	29.0 x 14.0 x 9.0 cm
No OF WORKERS NEEDED	2	2	2
FACTORY PRICE	745 ECUs	1 800 ECUs	375 ECUs
FOB PRICE	NOT COMMUNICATED	1 970 ECUs	NOT COMMUNICATED
OPTIONS	STABILIZING DEVICE	BLOCK CLAMP, HYDR. FLUID	NONE
TRAINING CONTRACT	NO	POSSIBLE	NO

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC : MOTORIZED PRESSES

DISTRIBUTOR	ALTECH	APPRO-TECHNO	CERATEC
MANUFACTURER	ALTECH	PLATBROOD F.	CERATEC
COUNTRY	FRANCE	BELGIUM	BELGIUM
DENOMINATION	PACT 500	SEMI-TERSTAMATIQUE	CERAMATIC
DEGREE OF INTEGRATION	PRESS	PRESS	PRESS
METHOD OF MOVING	HAULAGE	HAULAGE	HAULAGE
WORKING ENCUMBRANCES (l x w x h)	1.30 x 1.00 x 1.30 m	2.20 x 0.65 x 1.10 m	2.00 x 1.00 x 1.40 m
TRANSPORTATION ENCUMBRANCES (l x w x h)	1.20 x 1.10 x 1.40 m	2.27 x 0.75 x 1.12 m	2.26 x 1.14 x 1.66 m
NET WEIGHT	600 kg	880 kg	1 700 kg
PACKAGED WEIGHT	750 kg	1 000 kg	2 400 kg
ENERGY SOURCE	ELECTRIC MOTOR	ELECTRIC MOTOR / DIESEL	ELECTRIC MOT. / DIESEL / PETROL
ENERGY TRANSMISSION	MECHANICAL BY CAM	MECHANICAL BY CAM	MECHANICAL BY CAM
ENERGY CONSUMPTION	1.5 kW.h	1.2 kW.h - 1.2 l/hour	2.8 kW.h - 1.5 l/hour
HYDRAULIC FLUID CONSUMPTION	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
COMPRESSION	STATIC	STATIC	STATIC
AVAILABLE FORCE	300 kN	150 kN	200 kN
COMPRESSION PRESSURE	7.2 MPa	3.6 MPa	4.8 MPa
AVAILABLE PRESSURE AT THE END OF COMPRESSION	NOT COMMUNICATED	NOT COMMUNICATED	NOT COMMUNICATED
DYNAMIC EFFECT COEFFICIENT	1.0	1.2	1.1
COMPRESSION MODE	SIMPLE	SIMPLE	SIMPLE
COMPRESSION RATIO	1.83	1.42 (+ folding back lid)	1.70 (+ coniform roller)
COMPRESSION SPEED	LENGTH 5 s	NOT COMMUNICATED	NOT COMMUNICATED
VIBRATION FREQUENCY	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
VIBRATION AMPLITUDE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
MECHANISM FOR FILLING UP THE MOULD	FIXED HOPPER AND ROTATING MOULD	STORAGE TABLE	NONE
COMPRESSION MECHANISM	VERTICAL STROKE PISTON	VERTICAL STROKE PISTON	VERTICAL STROKE PISTON AND CONIFORM ROLLER
PISTON STROKE	85 mm	38 mm	60 mm
MOULD DEPTH	165 mm	143 mm	130 mm
No OF MOULDS / TABLE	4	1	3
TURNING OUT MECHANISM	VERTICAL STROKE PISTON	VERTICAL STROKE PISTON	VERTICAL STROKE PISTON
LENGTH OF CYCLE	8 s	12 s	6 s
No OF BLOCKS / CYCLE	1 (or 2 small sized)	1 (or 2 small sized)	1 (or 2 small sized)
THEORETICAL OUTPUT	450 blocks/hour	300 blocks/hour	600 blocks/hour
PRACTICAL OUTPUT	290 blocks/hour 8.6 m^3/8 hours	200 blocks/hour 5.9 m^3/8 hours	390 blocks/hour 9.0 m^3/8 hours
CATEGORIES OF BLOCK	1	1, 2, other components	1 (2 on request)
DIMENSION OF BLOCKS	29.5 x 14.0 x 9.0 cm	29.5 x 14.0 x 9.0 cm	29.5 x 14.0 x 7.0 cm
No OF WORKERS NEEDED	4	3	2
FACTORY PRICE	11 400 ECUs	8 400 ECUs / 9 000 ECUs	16 700 ECUs (electric)
FOB PRICE	12 200 ECUs	NOT COMMUNICATED	NOT COMMUNICATED
OPTIONS	MOTORIZED TABLE	MANY MOULDS	HYDRAULIC TRANSMISSION
TRAINING CONTRACT	POSSIBLE	POSSIBLE	POSSIBLE

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC : MOTORIZED PRESSES (continued)

DISTRIBUTOR	LA MÉCANIQUE RÉGIONALE		
MANUFACTURER	LA MÉCANIQUE RÉGIONALE		
COUNTRY	FRANCE		
DENOMINATION	DSH		
DEGREE OF INTEGRATION	PRESS		
METHOD OF MOVING	FORK-LIFT		
WORKING ENCUMBRANCES (l x w x h)	1.60 x 0.90 x 1.25 m		
TRANSPORTATION ENCUMBRANCES (l x w x h)	1.70 x 1.00 x 1.30 m		
NET WEIGHT	500 kg		
PACKAGED WEIGHT	560 kg		
ENERGY SOURCE	ELECTRIC MOTOR / DIESEL		
ENERGY TRANSMISSION	HYDRAULIC		
ENERGY CONSUMPTION	NOT COMMUNICATED		
HYDRAULIC FLUID CONSUMPTION	30 l TANK		
COMPRESSION	STATIC		
AVAILABLE FORCE	150 kN		
COMPRESSION PRESSURE	3.3 MPa (adjustable)		
AVAILABLE PRESSURE AT THE END OF COMPRESSION	3.3 MPa (adjustable)		
DYNAMIC EFFECT COEFFICIENT	1.0		
COMPRESSION MODE	DOUBLE		
COMPRESSION RATIO	1.50		
COMPRESSION SPEED	LENGTH 12 s		
VIBRATION FREQUENCY	NOT APPLICABLE		
VIBRATION AMPLITUDE	NOT APPLICABLE		
MECHANISM FOR FILLING UP THE MOULD	NONE		
COMPRESSION MECHANISM	2 HYDRAULIC JACKS WITH OPPOSITE VERTICAL STROKE		
PISTON STROKE	NOT COMMUNICATED		
MOULD DEPTH	180 mm		
No OF MOULDS / TABLE	3		
TURNING OUT MECHANISM	VERTICAL STROKE HYDRAULIC JACK		
LENGTH OF CYCLE	18 s		
No OF BLOCKS / CYCLE	1		
THEORETICAL OUTPUT	200 blocks/hour		
PRACTICAL OUTPUT	130 blocks/hour 5.6 m^3/8 hours		
CATEGORIES OF BLOCK	1		
DIMENSION OF BLOCKS	30.0 x 15.0 x 12.0 cm		
No OF WORKERS NEEDED	2		
FACTORY PRICE	10 700 ECUs / 12 150 ECUs		
FOB PRICE	NOT COMMUNICATED		
OPTIONS	CHASSIS ON TOW		
TRAINING CONTRACT	NO		

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC : MOBILE PRODUCTION UNITS

DISTRIBUTOR	GÉOBETON ONE	RAFFIN	
MANUFACTURER	GÉOBETON ONE	RAFFIN	
COUNTRY	FRANCE	FRANCE	
DENOMINATION	PRESS-BLOC 80 TM	DYNATERRE 01-4M	
DEGREE OF INTEGRATION	VIBRATING SIFTER HORIZONTAL SHAFT MIXER HOPPER PRESS	CONVEYOR BELT PLANETARY MIXER HOPPER PRESS	
METHOD OF MOVING	TOWED	TOWED	
WORKING ENCUMBRANCES (l x w x h)	4.62 x 2.22 x 2.95 m	7.90 x 2.40 x 3.60 m	
TRANSPORTATION ENCUMBRANCES (l x w x h)	4.62 x 2.22 x 2.40 m	5.80 x 2.40 x 3.60 m	
NET WEIGHT	3 500 kg	6 000 kg	
PACKAGED WEIGHT	3 800 kg	NOT COMMUNICATED	
ENERGY SOURCE	DIESEL ENGINE	ELECTRIC MOTOR	
ENERGY TRANSMISSION	HYDRAULIC	MECHANICAL AND HYDRAULIC	
ENERGY CONSUMPTION	5 l/hour	12 kW.h	
HYDRAULIC FLUID CONSUMPTION	200 l TANK	200 l TANK	
COMPRESSION	STATIC	DYNAMIC AND STATIC	
AVAILABLE FORCE	800 kN	350 kN (dynamic/static)	
COMPRESSION PRESSURE	19.7 MPa (adjustable)	1 MPa (adjustable)	
AVAILABLE PRESSURE AT THE END OF COMPRESSION	19.7 MPa (adjustable)	1 MPa (adjustable)	
DYNAMIC EFFECT COEFFICIENT	1.0	1.0	
COMPRESSION MODE	SIMPLE	SIMPLE	
COMPRESSION RATIO	2.16	2.00	
COMPRESSION SPEED	75.0 mm/s / 10.8 mm/s	400 mm/s	
VIBRATION FREQUENCY	NOT APPLICABLE	50 Hz	
VIBRATION AMPLITUDE	NOT APPLICABLE	3 mm	
MECHANISM FOR FILLING UP THE MOULD	FIXED HOPPER AND DRAWER-MOULD	FIXED HOPPER AND FILLING UP DRAWER	
COMPRESSION MECHANISM	VERTICAL STROKE HYDRAULIC JACK	VIBRATING TABLE AND VERTICAL STROKE HYDRAULIC JACK	
PISTON STROKE	195 mm (maxi)	550 mm (maxi)	
MOULD DEPTH	195 mm	220 mm	
No OF MOULDS / TABLE	1	1 (4 stamps)	
TURNING OUT MECHANISM	VERTICAL STROKE HYDRAULIC JACK	VERTICAL STROKE OF THE MOULD AND EJECTOR	
LENGTH OF CYCLE	8 s	40 s	
No OF BLOCKS / CYCLE	1	4	
THEORETICAL OUTPUT	450 blocks/hour	360 blocks/hour	
PRACTICAL OUTPUT	320 blocks/hour 9.4 m^3/8 hours	210 blocks/hour 26.9 m^3/8 hours	
CATEGORIES OF BLOCK	1 (2 on request)	1, 2, 3, other components	
DIMENSION OF BLOCKS	29.0 x 14.0 x 9.0 cm	40.0 x 20.0 x 20.0 cm	
No OF WORKERS NEEDED	4 - 5	5 - 6	
FACTORY PRICE	75 000 ECUs	69 000 ECUs	
FOB PRICE	NOT COMMUNICATED	70 200 ECUs	
OPTIONS	OTHER MOULDS	WIDE RANGE OF MACHINES	
TRAINING CONTRACT	NO	POSSIBLE	

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC : FIXED PRODUCTION UNITS

DISTRIBUTOR	RGF TERRE 2000	SARET	
MANUFACTURER	MÉCA-PROVENCE	SARET	
COUNTRY	FRANCE	FRANCE	
DENOMINATION	TMR 6750-40	TEROC T2A	
DEGREE OF INTEGRATION	PLANETARY MIXER CONVEYOR BELT HOPPER PRESS	MULTI-BUCKET-CHAIN, ROTATING SIFTER, CONVEYOR BELT, HORIZONTAL SHAFT MIXER, PRESS, EMPTYING DEVICE	
METHOD OF MOVING	FORK LIFT	CRANE	
WORKING ENCUMBRANCES (l x w x h)	7.70 x 3.80 x 2.70 m	5.90 x 3.20 x 3.40 m (multi-bucket-chain + 5.00 m)	
TRANSPORTATION ENCUMBRANCES (l x w x h)	NOT COMMUNICATED	NOT COMMUNICATED	
NET WEIGHT	3 600 kg	10 000 kg	
PACKAGED WEIGHT	4 790 kg	NOT COMMUNICATED	
ENERGY SOURCE	2 DIESEL ENGINES	DIESEL ENGINE	
ENERGY TRANSMISSION	HYDRAULIC	HYDRAULIC	
ENERGY CONSUMPTION	2 x 2.5 l/hour	13 l/hour	
HYDRAULIC FLUID CONSUMPTION	200 l TANK	600 l TANK	
COMPRESSION	STATIC	STATIC	
AVAILABLE FORCE	360 kN	1 800 kN	
COMPRESSION PRESSURE	8 MPa (adjustable)	17 MPa (adjustable) / 22 MPa	
AVAILABLE PRESSURE AT THE END OF COMPRESSION	8 MPa (adjustable)	17 MPa (adjustable) / 22 MPa	
DYNAMIC EFFECT COEFFICIENT	1.0	1.0	
COMPRESSION MODE	SIMPLE	SIMPLE + DOUBLE (perforation)	
COMPRESSION RATIO	1.83	1.70 - 2.00	
COMPRESSION SPEED	13.1 mm/s	NOT COMMUNICATED	
VIBRATION FREQUENCY	NOT APPLICABLE	NOT APPLICABLE	
VIBRATION AMPLITUDE	NOT APPLICABLE	NOT APPLICABLE	
MECHANISM FOR FILLING UP THE MOULD	FIXED HOPPER AND DRAWER-MOULD	FIXED HOPPER AND DRAWER-MOULD	
COMPRESSION MECHANISM	VERTICAL STROKE HYDRAULIC JACK	2 x 2 HYDRAULIC JACKS WITH OPPOSITE VERTICAL STOKE	
PISTON STROKE	NOT COMMUNICATED	240 mm (maxi)	
MOULD DEPTH	275 mm	240 mm (maxi)	
No OF MOULDS / TABLE	1	1	
TURNING OUT MECHANISM	VERTICAL STROKE HYDRAULIC JACK	2 VERTICAL STROKE HYDRAULIC JACKS	
LENGTH OF CYCLE	8 s	12 s	
No OF BLOCKS / CYCLE	1	2	
THEORETICAL OUTPUT	450 blocks/hour	600 blocks/hour	
PRACTICAL OUTPUT	320 blocks/hour 17.3 m^3/8 hours	420 blocks/hour 16.4 m^3/8 hours	
CATEGORIES OF BLOCK	1	1.2	
DIMENSION OF BLOCKS	30.0 x 15.0 x 15.0 cm	29.0 x 14.0 x 12.0 cm	
No OF WORKERS NEEDED	4 - 5	4 - 5	
FACTORY PRICE	57 100 ECUs	NOT COMMUNICATED	
FOB PRICE	NOT COMMUNICATED	143 000 ECUs (diesel)	
OPTIONS	ON TOW CHASSIS, SIFTER	4 WHEELS FOR SITE	
TRAINING CONTRACT	NO	NO	

ALTECH "GÉO 50"

Major distributor :
ALTECH
Société Alpine de Technologies Nouvelles
rue des Cordeliers
F-05200 EMBRUN
FRANCE
Telephone : (33) 92 43 21 90
Telex : 420 219

Historical background of the machine :
The first prototype of this machine was manufactured in 1984. The machine was first manufactured by SOUEN. ALTECH restarted manufacturing in 1986.

Description of the machine :
The machine is a low encumbrance manual press, that can be easily moved.

ALTECH "PACT 500"

Major distributor :
ALTECH
Société Alpine de Technologies Nouvelles
rue des Cordeliers
F-05200 EMBRUN
FRANCE
Telephone : (33) 92 43 21 90
Telex : 420 219

Historical background of the machine :
The current machine is a development of the first machine manufactured by the company, the "PACT 315" press, introduced in 1981.

Description of the machine :
The machine is a medium encumbrance motorized press, easily moveable on the site or on the road when it is fitted with the 2 original pneumatic wheels.
The mechanically preprogrammed filling, compression and turning out cycle is set in motion manually. The filling of the mould is done by means of a fixed hopper.

APPRO-TECHNO "SEMI-TERSTAMATIQUE"

Major distributor :
APPRO-TECHNO.
rue de la Rièze 24
B-6404 COUVIN - CUL-DES-SARTS
BELGIUM
Telephone : (32) 60 37 76 71
Telex : 51622

Historical background of the machine :
The machine is a completely revised version of the "LA MAJO" formerly manufactured by the ATELIERS DE CONSTRUCTION DE VILLERS-PERWIN. The machine was first introduced in 1982

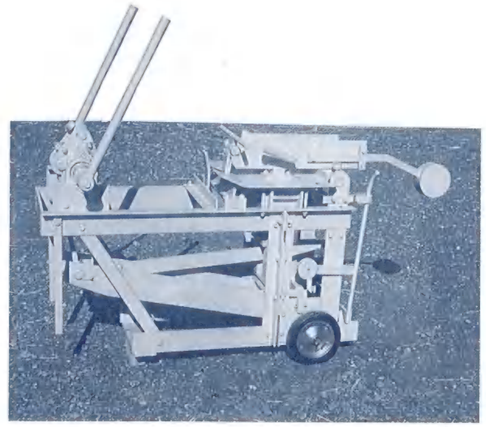
Description of the machine :
The machine is a motorized press, fitted with 4 small wheels and is movable on the site.
The mechanically preprogrammed filling, compression and turning out cycle is set in motion manually. The filling of the mould is done manually.

APPRO-TECHNO "TERSTARAM"

Major distributor :
APPRO-TECHNO.
rue de la Rièze 24
B-6404 COUVIN - CUL-DES-SARTS
BELGIUM
Telephone : (32) 60 37 76 71
Telex : 51622

Historical background of the machine :
The machine is a completely revised version of the "LA MADELON" (1904) formerly manufactured by the ATELIERS DE CONSTRUCTION DE VILLERS-PERWIN. The machine was first introduced in 1979.

Description of the machine :
The machine is a heavy manual press, fitted with 2 small wheels and is movable on the site.



CERATEC "CERAMAN"

Major distributor :
CERATEC
rue du Touquet 228
B-7793 PLOEGSTEERT
BELGIUM
Telephone : (32) 56 58 86 45
Telex : 57834

Historical background of the machine :
The machine is a completely revised version of the "LA MADELON" (1904) formerly manufactured by the ATELIERS DE CONSTRUCTION DE VILLERS-PERWIN. The machine was first introduced in 1981.

Description of the machine :
The machine is a heavy manual press, fitted with 2 small wheels and is movable on the site.

CERATEC "CERAMATIC ME"

Major distributor :
CERATEC
rue du Touquet 228
B-7793 PLOEGSTEERT
BELGIUM
Telephone : (32) 56 58 86 45
Telex : 57834

Historical background of the machine :
The machine is a completely revised version of the "LA MAJOMATIC" formerly manufactured by the ATELIERS DE CONSTRUCTION DE VILLERS-PERWIN. The machine was first introduced in 1983.

Description of the machine :
The machine is a motorized press, fitted with 4 small wheels and is movable on the site.
The mechanically preprogrammed filling, compression and turning out cycle is completely automatic and continuous. The filling of the rotating mould is done manually.

GÉOBETON ONE "PRESS-BLOC 80 TM"

Major distributor :
GÉOBETON ONE
82, boulevard Denis Papin
BP 91
F-53021 LAVAL CEDEX
FRANCE
Telephone : (33) 43 68 25 06
Telex : 722 603

Historical background of the machine :
The current machine was first introduced in 1984. It is an advanced version of the company's first machine, the "H 60" press.

Description of the machine :
The machine is a mobile production unit, mounted on a chassis on tow with 4 pneumatic wheels, in conformity with road-transport standards.
The production unit is motorized by a single motor and features a vibrating sieve, a horizontal shaft mixer, a hopper and a press.
There are two distinct main systems that are independently operated.
The feeding of the sieve is done manually. Once the earth is sifted, it is put into the mixer by a funnel loader. The addition of water and/or a stabilizer is done manually, directly into the mixer. The opening of the mixer and the dumping of the hopper are done automatically.
The filling, compression and turning out cycle is operated automatically and is controlled independently from the other operations by a programmed automaton. This device contains a release mechanism.

MULTIBLOC "BREPAK"

Major distributor :
MULTIBLOC
WELDING INDUSTRIES LTD
Blackswarth Road
GB-BS5 8AX BRISTOL
UNITED KINGDOM
Telephone : (44) 272 55 19 51
Telex : 44716

Historical background of the machine :
The machine was designed in the late 1970s by the BUILDING RESEARCH ESTABLISHMENT UK.

Description of the machine :
The machine is a low encumbrance manual press that can be easily moved, fitted with a hydraulic jack to ensure high compression pressure.

LA MÉCANIQUE RÉGIONALE "DSH"

Major distributor :
LA MÉCANIQUE RÉGIONALE
23, rue de la Gare
F-51140 MUIZON
FRANCE
Telephone : (33) 26 02 95 75.
Telex : 306 022

Historical background of the machine :
The design of the "DSH" is a follow-up to the "DSM" manual press, aimed at improving output and the mechanical characteristics of the blocks produced. The machine was first introduced in 1987.

Description of the machine :
The machine is a motorized press, movable with the assistance of a fork-lift trolley or on a chassis on tow fitted with 2 wheels (option).
The preprogrammed filling, compression and turning out cycle, is set in motion manually. The filling of the rotating mould is done manually.

LA MÉCANIQUE RÉGIONALE "DSM"

Major distributor :
LA MÉCANIQUE RÉGIONALE
23, rue de la Gare
F-51140 MUIZON
FRANCE
Telephone : (33) 26 02 95 75.
Telex : 306 022

Historical background of the machine :
The design is based upon a study of manual presses of the same type and the use of the double compression process.

Description of the machine :
The machine is a low encumbrance manual press that can be easily moved. The machine was first introduced in 1985.

RAFFIN "DYNATERRE 01-4M"

Major distributor :
RAFFIN
700, route de Grenoble
BP 9 Domène
F-38420 LE VERSOUD
FRANCE
Telephone : (33) 76 77 15 27
Telex : 320 802

Historical background of the machine :
The "DYNATERRE" range of machines is based on research into the production of earth blocks by static compression and dynamic compression by vibration (vibrocompaction). The research was done in collaboration with the School of Architecture of Saint-Etienne (France). The first version of the machine was introduced in 1981.

Description of the machine :
The machine is a mobile production unit, mounted on a chassis on tow, in conformity with road-transport standards, and is fitted with 2 pneumatic wheels.
The production unit includes a conveyor belt, a planetary mixer, a water tank, a hopper and a press.
The production unit is motorized with an electric motor. A generator set is delivered as an optional extra.
The feeding of the earth and the stabilizer is carried out by a hopper. The mixer is controlled manually. The filling, vibration, compression, turning out and evacuation operations are set in motion manually in succession, with the possibility of repeating certain operations.

RGF TERRE 2000 "TMR 6750-40"

Major distributor :
RGF TERRE 2000
Les Lauzes
Quartier Jentelin
BP 113
F-13160 CHATEAURENARD
FRANCE
Telephone : (33) 90 94 04 86
Telex : 431 919

Historical background of the machine :
This machine was designed in 1984 and it is based upon an original prototype manufactured in 1982.

Description of the machine :
The machine is a fixed production unit. The mixer is fitted with 2 wheels, the press is mounted on a rigid chassis or mounted on a chassis on tow fitted with 4 wheels (option).
The production unit integrates a planetary mixer, a conveyor belt, a hopper and a press.
The production unit is composed of two main systems that are motorized and controlled independently.
The feeding of the mixer is done by a skip loader. The filling, compression and turning out cycle is done automatically and controlled independently of the other operations by an electrical-mechanical device. This device contains a release mechanism.

SARET "TEROC T2A"

Major distributor :
SARET
Société de Recherche et d'Etudes Techniques
route de Carpentras
BP 73
F-84130 LE PONTET
FRANCE
Telephone : (33) 90 32 90 13
Telex : 431 026

Historical background of the machine :
The current machine is an improved version of the company's first machine the "T1A" introduced in 1980.

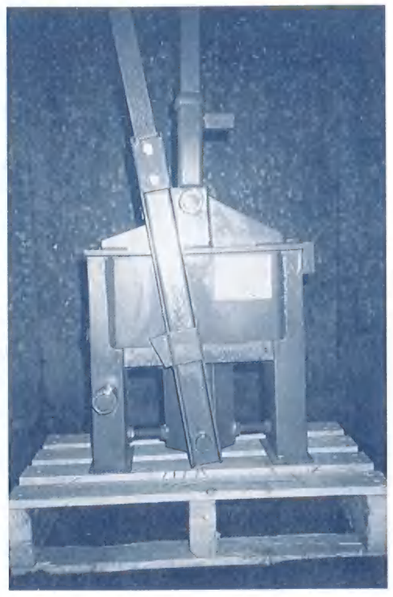
Description of the machine :
The machine is a fixed production unit, that can be moved with the assistance of a crane or a winch, or towed on the site if equipped with 2 rigid metallic wheeled axles, delivered as an optional extra.
The production unit includes a multi-bucket-chain, a rotating sieve, a small conical rotary hopper, a conveyor belt, a horizontal shaft mixer, a hopper, a press, a device to empty out the blocks and a stacking clamp.
The production unit is motorized by a single engine.
There are two distinct main systems which are controlled independently.
The multi-bucket-chain brings the earth to the sieve. The sifted earth falls into a small conical hopper devided vertically in two parts. The addition of the stabilizer is done manually into the hopper.
When the hopper is half-filled, it is manually turned around 180° in order to feed the conveyor belt and the mixer. Water is added directly into the mixer, which is situated on top of the hopper, by means of a hydraulic control mechanism. The filling, compression and turning out cycle is done automatically and is controlled independently of the other operations by an electrical-mechanical device. This device contains a release mechanism.

UNATA "1003"

Principal distributeur :
UNATA
Union pour l'Assistance Technologique Appropriée
G. Van den Heuvelstraat 131
B-3140 RAMSEL
BELGIUM
Telephone : (32) 16 56 10 22
Telex : 21874

Historical background of the machine :
The machine is based upon the "CINVA-RAM".

Description of the machine :
The machine is a low encumbrance manual press, that is easily moved. The first version of the machine was introduced in 1978.



OTHER DEVELOPMENTS

These models are either prototypes under development, or adaptations of existing presses, usually of the "CINVA-RAM" type (low encumbrance light manual press, with transmission of the energy by means of a lever), produced by non-commercial organizations in small quantities, or machines with origins in the concrete industry which manufacturers or distributors are attempting to adapt for the production of compressed earth blocks.

OTHER DEVELOPMENTS : SUMMARY TABLE

DESIGNER	COUNTRY	MACHINE	TYPE
AVM	FR GERMANY	"CINVA-RAM" TYPE	MANUAL PRESS
CITADOB INTERNATIONAL	BELGIUM	PTC-240 P	FIXED UNIT
CITADOB INTERNATIONAL	BELGIUM	PTC-240 A	FIXED UNIT
CLU INTERNATIONAL LTD	UNITED KINGDOM	CLU 2000 UNIBRICK MACHINE	MOBILE UNIT
GIZA SPA	ITALY	VIBROCOMPACTION UNITS	FIXED UNIT
HYPERBRICK SA	SPAIN	CONTAINER MP 30	FIXED UNIT
LE FOUR INDUSTRIEL BELGE	BELGIUM	"LA MADELON" TYPE	MANUAL PRESS
LES ATELIERS DU PROGRÈS	FRANCE	MEGABRIK	MOBILE UNIT
LUCE SA	FRANCE	GÉOLUCE 2000 M	FIXED UNIT
LUCE SA	FRANCE	GÉOLUCE 2000 A	FIXED UNIT
LUCE SA	FRANCE	GÉOLUCE 6000 A	FIXED UNIT
RIFFON J.	BELGIUM	IMPACT PRESS	MANUAL PRESS
TH DELFT	THE NETHERLANDS	"CINVA-RAM" TYPE	MANUAL PRESS

Descriptions of the above equipment follow on page 32.

AVM

Ausbildungsverbund Metall
Bernhard-Adelung-Straße 42
D-6090 RUSSELSHEIM
FEDERAL REPUBLIC OF GERMANY
Telephone : (49) 61 42 630 71

Manual press "CINVA-RAM" type :
A replica of the "CINVA-RAM", using as many DIN standard parts as possible, produced occasionally in small numbers by AVM, which can supply the plans and the list of parts for the manufacture of this press.

CITADOB INTERNATIONAL

rue du Beau Site 21
B-1050 BRUSSELS
BELGIUM
Telephone : (32) 26 47 38 20
Telex : 20611

"PTC-240 P" fixed production unit :
Prototype developed entirely in Belgium, on the basis of experience obtained by CITADOB with the Brazilian LUXOR "PTL-4" press. Development of this prototype has not yet been completed. The mechanism is very complex and sophisticated, as are the interlocking blocks produced.

"PTC-240 A" fixed production unit :
This design is derived from the other CITADOB unit, and retains the main characteristics of the latter. The machine, currently under construction, is entirely containerized.

CLU INTERNATIONAL LTD

Finance House
19 Craven Road
GB-W2 3BP LONDON
UNITED KINGDOM
Telephone : (44) 1 402 58 97

"CLU 2000 UNIBRICK MACHINE" mobile production unit :
One of the many versions of the "CLU 2000", originally designed in Ghana by UNICLEAN GHANA LTD and manufactured for the Swiss firm CONSOLID by LESCHA in West Germany. The present version is manufactured by the British company ALVAN BLANCH DEVELOPMENT COMPANY.

GIZA SPA

Agro-Zootechnie Industrielle
I-42011 BAGNOLO IN PIANO (RE)
ITALY
Telephone : (39) 52 26 14 03
Telex : 530 053

Fixed production units using vibrocompaction :
Concrete block production units which may be adapted for the production of compressed earth blocks, using static compression and dynamic compression by vibration (vibrocompaction), developed at the Saint-Etienne School of Architecture (France).

HYPERBRICK SA

Juan Bravo, 58
E-MADRID 6
SPAIN
Telephone. : (34) 402 79 41
Telex : 46146

Fixed production unit "CONTAINER MP 30" :
Production unit entirely surrounded within a standard 20 feet maritime container.

LE FOUR INDUSTRIEL BELGE

rue des Trois Arbres 14
B-1180 BRUSSELS
BELGIUM
Telephone : (32) 23 76 11 50
Telex : 22944

Manual press "LA MADELON" type :
Evolution of the "LA MADELON" press (refer to the "CERAMAN" press). Production discontinued.

LES ATELIERS DU PROGRÈS

Groupe SIFI
23, avenue Mont-Fleury
F-06300 NICE
FRANCE
Telephone : (33) 93 89 24 01
Telex : 970 826

Mobile production unit "MEGABRIK" :
Prototype which integrates a press, with hydraulic energy transmission, and a planetary mixer.

LUCE SA

LP 550
avenue du Québec
Z.A. de Courtabœuf
F-91946 LES ULIS CEDEX
FRANCE
Telephone : (33) 1 69 28 89 00
Telex : 603 158

"GÉOLUCE 2000 M", "GÉOLUCE 2000 A" and "GÉOLUCE 6000 A" fixed production units :
Production units using the impact method of dynamic compression (hammering). These machines have proven themselves in the concrete industry, particularly for the production of slabs and pavement kerbstones in fine concrete. The production of compressed earth blocks has been demonstrated.

RIFFON J.

rue J. Wilgot 6
B-5220 ANDENNE
BELGIUM

Impact manual press :
Press occasionally manufactured by an artisan.

TH DELFT

Afdeling der Civiele Techniek
IV Stevinlab
4 Stevinweg
NL-2628 CN DELFT
THE NETHERLANDS
Telephone : (31) 15 78 91 11

Manual press "CINVA-RAM" type :
Plans for the production of this press are available.

PULVERIZERS

THE TASK

In order to obtain a homogeneous mixture of the mineral constituents, the water and stabilizer, where present, one must first break up the lumps of earth, which can attain a diameter of 200 mm or more, after extraction. The purpose is to leave the homogeneous grains (pebbles, gravel) intact and to disintegrate the reconstituted grains, that are bound by the clay fraction present.

TYPES OF EQUIPMENT

Jaw grinders :
In addition to motorized pulverizers of this type, there are also manual models fitted with a simple pendulum mechanism with an output of about 3 to 4 m^3 a day ; these cost about 4 000 ECUs.

"Carr" type pulverizers :
These consist of two concentric disks turning in opposite directions, each of which is equipped with series of bars which strike the earth at a very high speed. There are motorized and manual versions of this system attaining an output of about 10 m^3 a day ; these cost about 2 500 ECUs.

Squirrel cage pulverizers :
These are motorized and consist of two squirrel cages, placed relatively closely together, turning, at very high speeds, in opposite directions. These models have an output of about 15 to 25 m^3 a day ; these cost about 3 000 ECUs.

Sledgehammer pulverizers :
These are motorized and consist of a series of sledgehammers mounted, by means of springs, on a central rotating shaft. The sledgehammers hit the earth at a very high speed. These models have an output of about 40 m^3 a day ; these cost about 4 500 ECUs.

Propeller pulverizers :
These are motorized and are very similar to machines used to shred compost. These models have an output of about 15 m^3 a day ; these cost about 3 000 ECUs.

Cogged conveyor belt pulverizers :
These are motorized and consist of a cogged conveyor belt which conveys the earth through a kind of comb where it is pulverized and projected. These models have an output of about 30 m^3 a day ; these cost about 3 000 ECUs.

TECHNICAL SELECTION CRITERIA

The pulverizers must be able to produce earth in which at least 50 % of the reconstituded grains (bound by clay) have a diameter of less than 5 mm and 100 % less than 10 mm. Only the top range motorized pulverizers can treat humid soil, which is a considerable advantage.
The machines which pulverize the earth between two jaws, could also crush the pebbles, which would be undesirable as they can be needed for correct grain size distribution. This type of pulverizer is only useful when treating uniform fine soil.
For the less efficient machines, it might be useful to place a screen where the earth comes out of the pulverizer, thus permitting the evacuation of the large rejected particles.

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC

Some of the mobile or fixed production units are fitted with a pulverizer.
Apart from these units, the following mixers are produced in the EEC :

APPRO-TECHNO

rue de la Rièze 24
B-6004 COUVIN - CUL-DES-SARTS
BELGIUM
Telephone : (32) 60 37 76 71
Telex : 51622.

Squirrel cage pulverizer :
Practical daily output ≃ 15 - 25 m^3.
Price ≃ 1 800 ECUs electric motor, 3 000 ECUs diesel engine.

CERATEC

rue du Touquet 228
B-7793 PLOEGSTEERT
BELGIUM
Telephone : (32) 56 58 86 45
Telex : 57834.

Squirrel cage pulverizer "CERADES H2" :
Practical daily output ≃ 15 - 25 m^3.
Price ≃ 3 000 ECUs electric motor, 4 500 ECUs diesel engine.

INTERMEDIATE TECHNOLOGY WORKSHOPS

J.P.M. Parry and Associates Ltd.
Overend Road
GB-B64 7DD CRADLEY HEATH
UNITED KINGDOM
Telephone : (44) 3 846 91 71
Telex : 334 132

Manual jaw grinders with combined fixed screen (two models produced) :
Practical daily output ≃ 3 - 4 m^3 (largest one).
Price ≃ 3 600 ECUs (largest one).

SIEVES

THE TASK

Sifting is indispensable either when the earth has texture defects (overly-large particles or organic content) or when the pulverization is imperfect. The most appropriate grain diameter depends upon the construction technique aimed at and the specifications of the construction project.

TYPES OF EQUIPMENT

Fixed screens :
Placed in an inclined or suspended position, these screens are manual and easy to manufacture.
They necessitate a triple manipulation : throwing a shovelful of coarse earth against the screen, recuperating the sifted earth in a wheelbarrow, disposal of the earth rejected by the screen. These models have an output, per worker, of about 5 to 8 m^3 a day.

Rotating sieves :
These consist of a manually operated or motorized rotating metal or grate cylinder. The construction is simple. It is possible to sift in sucession and divide the earth into several portions which permits the reconstituting of the earth with selected portions. These models have an output of about 40 m^3 a day and cost about 4 500 ECUs.

Vibrating sieves :
These are motorized and consist of one vibrating sieve only or a combination of several screens, generally superimposed. Successive sifting is possible, enabling, the division of the earth into several portions, which again allows for the reconstituting of the earth with selected portions. Vibrating sieves are generally designed for huge production units. These machines are often complex, heavy and consume large amounts of energy. These models have an output of about 40 m^3 a day and cost about 7 500 ECUs.

TECHNICAL SELECTION CRITERIA

When producing compressed earth blocks, only the fraction of earth smaller than 15 or 20 mm in diameter is used, sometimes even smaller than 5 mm. 5 mm for earth intended for presses very sensitive to compression forces and for blocks with relatively fine partitions and side panels (30 to 50 mm) ; 15 or 20 mm for presses that are less sensitive to compression forces (hyper compression). For any given type of earth, the most efficient sifting systems are those which throw out the least amount of earth. The best systems allow for the sifting of dry or wet earth, or even very moist earth.

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC

Some of the mobile or fixed production units, or some of the pulverizers are fitted with a sieve.
Apart from these units, the EEC does not produce any other commercialized equipment specifically designed for earth construction.

MIXERS

THE TASK

The mixing process is particularly important for the final quality of the product. A homogeneous mixture is indispensable. It is preferable to start with the dry mixing operation. In order to obtain a homogeneous humidification, the water should be added to the dry mixture either in gushes, fine spray, in droplets or in steam under pressure, according to the construction technique and the level of sophistication employed.

TYPES OF EQUIPMENT

Cement concrete mixers :
This refers to classical cement concrete or mortar mixers used on construction sites, either manual or motorized. These models have an output of about 8 to 10 m^3 a day ; these cost about 1 000 ECUs.

Motor-cultivators :
These are motorized and consist of a series of milling cutters mounted on a rotating horizontal shaft which allows for the simultaneous pulverizing and mixing of the earth. These models have an output of about 8 to 10 m^3 a day ; these cost about 1 000 ECUs.

Planetary mixers :
These are motorized and consist of blades fixed to a vertical rotating shaft which turns inside a tank. The blade movement is more or less complex depending on the level of sophistication of the mechanisms. There are also models where the tank rotates. These models have an output of about 15 m^3 a day ; these cost about 4 500 ECUs.

Linear mixers :
These are motorized and consist of blades fixed to a shaft in the form of a discontinuous or continuous helical screw which turns inside a horizontal or vertical cylindrical tank. The horizontal systems are more sophisticated than the vertical since they often consist of a double tank equipped with two axles. These models have an output of about 20 m^3 a day ; these cost about 4 500 ECUs.

Grindstone mixers :
These are motorized and consist of two grindstones that turn inside a tank. These models have an output of about 15 m^3 a day ; these cost about 3 000 ECUs.

Horizontal shaft mixers :
These are motorized and consist of a series of blades fixed to a horizontal rotating shaft which turns inside a horizontal cylindrical tank, often of very reduced dimensions. These models have an output of about 10 m^3 a day ; these cost about 3 000 ECUs.

TECHNICAL SELECTION CRITERIA

Mixers must be extremely resistant to abrasive wear, particularly if treating lateritic earth.
The power absorbed for mixing earth is much higher than that absorbed for mixing cement concrete. The useful capacities of these machines indicated by the manufacturers often refer to the data concerning the process of mixing cement concrete and must therefore be reduced for mixing earth.
When using mixers for the preparation of earth to be used for the production of compressed earth blocks, the machine must be capable of mixing the earth for 3 to 4 minutes, in order to obtain optimum results.
These systems must never produce conglomerate balls of earth.
For the production of compressed earth blocks, the only mixers usable are the motor-cultivators, planetary mixers, linear mixers and horizontal shaft mixers.

INVENTORY OF EQUIPMENT PRODUCED IN THE EEC

Some of the mobile or fixed production units are fitted with a mixer.
Apart from these units, the following mixers are produced in the EEC :

APPRO-TECHNO
rue de la Rièze 24
B-6404 COUVIN - CUL-DES-SARTS
BELGIUM
Telephone : (32) 60 37 76 71
Telex : 51622

Planetary mixer :
Practical daily output ≃ 15 m^3.
Price ≃ 4 000 ECUs electric motor, 5 300 ECUs diesel engine.

CERATEC
rue du Touquet 228
B-7793 PLOEGSTEERT
BELGIUM
Telephone : (32) 56 58 86 45
Telex : 57834

Linear mixer "CERAMIX".

ESA-SED
1854, route de Saint-Romain
BP 2
F-42153 RIORGES
FRANCE
Telephone : (33) 77 71 97 77
Telex : 300 985

Planetary mixers "CMD 250 LC", "CMD 320 LC" and "CMD 500 LC" :
Practical daily output ≃ 15 - 25 m^3 depending on models.
Price ≃ 2 500 to 5 000 ECUs depending on models and options.

CHAPTER IV
BRICKWORKS

TYPES OF BRICKWORKS

The following table gives typical examples of artisan and industrial brickworks designed to operate on a permanent and well-organized basis, with adequate resources in line with initial investment.

TYPES OF BRICKWORKS

	TYPE 1 MANUAL	TYPE 2 MANUAL	TYPE 3 SEMI-MECHANIZED	TYPE 4 MECHANIZED
PRODUCTION/DAY (standard blocks 29.5 x 14 x 9 cm)	600 - 700	1 200 - 1 400	1 400 - 2 000	1 400 - 2 000
MACHINES	1 manual press	2 manual presses 1 250 l mixer	1 motorized press	1 motorized press 1 250 l mixer 1 manual fork-lift
TOTAL AREA (m^2)	380 (10 closed and 30 covered)	530 (15 closed and 100 covered)	800 (20 closed and 80 covered)	800 (15 closed and 40 covered)
NUMBER OF OPERATIVES	9 - 10	11 - 13	12 - 14	9 - 10
SUPERVISORS	1	1	1	1
CEMENT/DAY (kg) (stabilization 6 %)	230 - 270	460 - 540	540 - 760	540 - 760
ENERGY/DAY (litres of gas oil)	0	8 - 10	10 - 15	20 - 25
MACHINERY INVESTMENT COST (ECUs)	2 250	11 000	12 600	26 600
INFRASTRUCTURE INVESTMENT COST (ECUs)	750	1 700	1 850	1 300
INVESTMENT TOTAL COST (ECUs)	3 000	12 700	14 450	27 900

NOTE :
Investment costs estimated in the context of the village Afotobo, near Béoumi and Bouaké (Ivory Coast).
Value October 1987.

TYPES OF BRICKWORKS (continued)

	TYPE 5 MECHANIZED	TYPE 6 SEMI-AUTOMATIC	TYPE 7 AUTOMATIC	TYPE 8 SEMI-INDUSTRIAL
PRODUCTION/DAY (standard blocks 29.5 x 14 x 9 cm)	2 800 - 4 000	2 000 - 2 600	2 000 - 2 600	2 400 - 3 400
MACHINES	2 motorized presses 1 pulverizer 1 500 l mixer 3 conveyor belts 1 motorized fork-lift 1 manual fork-lift	1 mobile unit 1 pulverizer 1 manual fork-lift	1 mobile unit 1 manual fork-lift	1 fixed unit 1 motorized fork-lift 1 manual fork-lift
TOTAL AREA (m^2)	3 250 (30 closed and 90 covered)	1 700 - 3 000 (10 - 30 closed and 40 - 50 covered)	1 700 - 3 000 (10 - 30 closed and 40 - 50 covered)	3 200 - 5 000 (70 - 100 closed and 280 - 340 covered)
NUMBER OF OPERATIVES	9 - 12	9 - 13	8 - 11	10 - 11
SUPERVISORS	1	1	1	2
CEMENT/DAY (kg) (stabilization 6 %)	1 080 - 1 520	760 - 990	760 - 990	910 - 1 290
ENERGY/DAY (litres of gas oil)	50 - 60	50 - 60	40 - 50	110 - 120
MACHINERY INVESTMENT COST (ECUs)	65 600	113 500	109 700	246 300
INFRASTRUCTURE INVESTMENT COST (ECUs)	7 700	6 000	6 000	40 000
INVESTMENT TOTAL COST (ECUs)	73 300	119 500	115 700	286 300

NOTE :
Investment costs estimated in the context of the village Afotobo, near Béoumi and Bouaké (Ivory Coast).
Value October 1987.

CHAPTER V
SELECTION OF PRODUCTION EQUIPMENT FOR BRICKWORKS

SELECTION METHOD

The selection of equipment which is appropriate for the specific conditions of its future operational environment is a complex process. The number of parameters and criteria involved can be very large. It is therefore essential to follow a logical and pragmatic procedure for making the best choice.

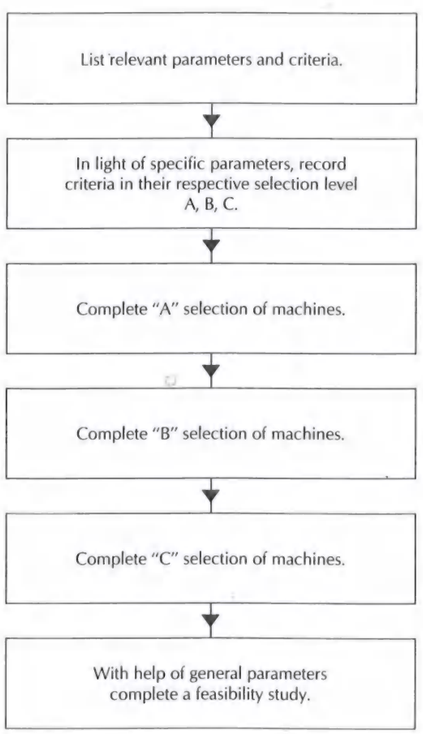
The method proposed here makes use of two sorts of data and involves three levels of selection.

The two sorts of data are :
1. parameters,
2. criteria.

The three levels of selection are, in order :
1. key requirements (A),
2. additional requirements (B),
3. final selection (C).

The flow chart below shows how data is used in relation to the level of selection :

SIMPLIFIED SELECTION FLOW CHART



It is important to note that the selection of appropriate equipment must necessarily include a feasibility study, which involves considerably more than a simple calculation of the cost price of the product. The feasibility study is carried out at the end of the selection procedure. If the results of such a study were included from the beginning of the selection procedure, a feasibility study would have to be carried out for each machine. This would be costly and unjustified, given the complexity of such studies.

In some cases the process of selecting appropriate equipment may turn out to be too complex. In such circumstances the file may be handed over to CDI who may commission CRATerre to study it. This could result in :
1. equipment selection,
2. the preliminary feasibility study,
3. the organization of the brickworks,
4. the implementation plan.

STEPS OF SELECTION PROCESS

STEP 1 : PREPARATION OF PARAMETERS AND CRITERIA

1.1 Each environment and context requires a modification of the list of parameters and criteria. In general, the parameters list is of more or less universal application and does not need other than minor changes. In contrast, the criteria list may require substantial modification.

1.2 The criteria must be examined in detail, in the light of the specific parameters, so that those which are absolutely relevant are selected. Great care should be taken with this choice.

1.3 The chosen criteria should be examined with respect to the three levels of selection A, B and C and recorded on the corresponding sheets. Specific as well as general or technical criteria may be involved at each of the three levels of selection.

STEP 2 : KEY REQUIREMENTS

2.1 Whether the machines satisfy the criteria or not is indicated by YES or NO on the sheet. Those machines that satisfy the criterion or criteria are selected, the others are rejected.

2.2 If no machine is selected, the criteria must clearly be revised and the procedure repeated.

2.3 If just one machine is selected there is no reason to continue the procedure and the feasibility study is started immediately. If several machines meet the criteria the procedure is continued.

STEP 3 : ADDITIONAL REQUIREMENTS

3.1 This step is based on multiple criterion analysis. The best machine or machines are selected on the basis of the additional requirements put forward.

3.2 If just one machine is selected there is no reason to continue the procedure and the feasibility study is started immediately. If several machines are selected the procedure is continued.

STEP 4 : FINAL SELECTION

4.1 Final selection is a relatively simple subjective procedure.

STEP 5 : FEASIBILITY STUDY

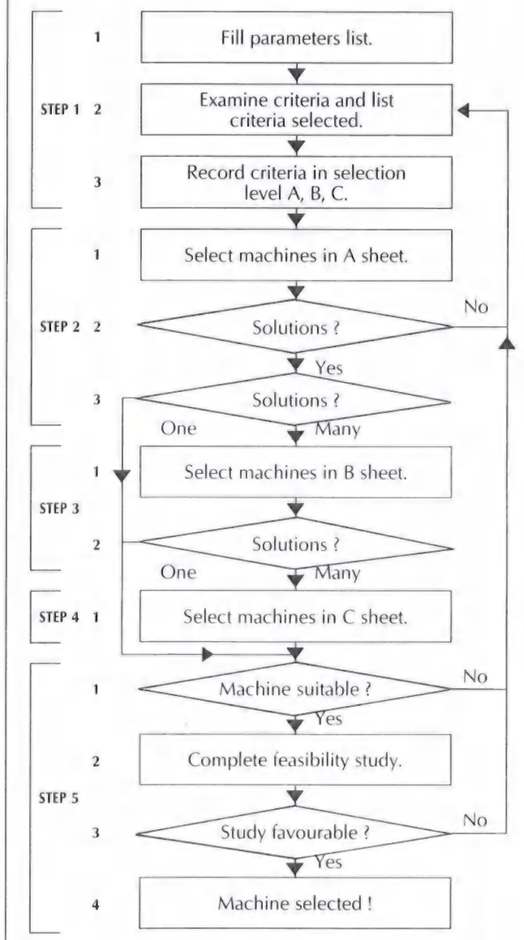
5.1 Whatever selection method is employed, the final selection always involves a degree of subjectivity. The person responsible for the selection must therefore be "satisfied" with the choice made. If they are not, the whole procedure must be repeated.

5.2 It is always absolutely necessary to perform a feasibility study, a sophisticated operation which, if carried out in a professional manner, involves a large number of parameters.

5.3 If the feasibility study does not produce a favourable result, either the entire selection procedure must be started again, or the interpretation of the feasibility study results must be reconsidered.

5.4 Equipment selection is complete, and has been carried out on an informed basis.

DETAILED SELECTION FLOW CHART



NOTE : Steps 1 to 4 are described in detail on pages 40 to 43.

PARAMETERS

A "parameter" comprises quantitative or qualitative information that facilitates :

1. project definition (specific parameters),
2. verification of project feasibility (general parameters).

SPECIFIC PARAMETERS

These parameters are directly related to the project and involve the following points (non-exhaustive check list) :
— status of the builder,
— use of the project,
— environment,
— participants,
— construction method,
— project specification.

Refer to the detailed list in "QUESTIONNAIRE".

GENERAL PARAMETERS

These parameters are related to the general environmental or market conditions and include the following points (non-exhaustive check list) :
— water and energy,
— light and heavy lubricating oils,
— equipment,
— tooling, small equipment items and supplies,
— transport and communications,
— labour and management staff,
— average output,
— production environment,
— currency,
— import charges,
— depreciation,
— financial and insurance charges.

Refer to the detailed list in "QUESTIONNAIRE".

CRITERIA

A "criterion" comprises quantitative or qualitative information that facilitates :

1. The elimination of unsuitable equipment at the first selection stage, on the grounds that it does not satisfy the mandatory conditions put forward (mainly specific criteria and/or general criteria).

2. The selection of equipment at the second level, satisfying requirements which are desirable but not mandatory (mainly general criteria and/or specific criteria).

3. The final selection of the appropriate equipment at the final level (mainly technical criteria).

SPECIFIC CRITERIA

These criteria are directly related to the project and mainly concern the following points :
— product quality criteria,
— financial criteria,
— micro-economic criteria.

The principal criteria are described in detail under the headings "KEY REQUIREMENTS", "ADDITIONAL REQUIREMENTS" and "FINAL SELECTION".

GENERAL CRITERIA

These criteria are related to the general environmental or market conditions and mainly involve the following points :
— macro-economic criteria,
— professional qualification criteria,
— socio-cultural criteria,
— operational criteria,
— development criteria,
— environmental criteria.

The principal criteria are described in detail under the headings "KEY REQUIREMENTS", "ADDITIONAL REQUIREMENTS" and "FINAL SELECTION".

TECHNICAL CRITERIA

These criteria are related to the equipment being evaluated. These criteria are described in detail under the heading "TECHNICAL SELECTION CRITERIA", for each category of equipment.

KEY REQUIREMENTS (A)

PROCEDURE

Selection of key requirements is based on the assumption that a certain number of machines will be eliminated for not satisfying one or more of the selection criteria. The response for each machine and for each criterion is expressed as "yes" or "no", formalized by a box marked with a cross (yes) or unmarked (no) on the key requirements sheet. In the first column, the results column, the machine or machines picked out by this procedure are indicated.

PRINCIPAL CRITERIA : KEY REQUIREMENTS

In principle, many criteria could be proposed for this selection. Experience shows that the most relevant criteria often include the following (not in order) :

Cost :
Budgetary restrictions place a considerable limitation on equipment selection. Ancillary costs (transport, customs clearance, spare parts, auxiliary equipment, etc.) must be taken into account, as well as the purchase price of the machine.

Source :
This criterion must be correctly phrased. The condition "Purchase a machine manufactured in country X" will not eliminate the same machines as the condition "Purchase a machine in country X" or the condition "Purchase a machine in the currency of country X".

Output :
The quantity of blocks required in a given time is a very important factor in the choice of machines. In combination with other data the influence of output on the choice can be variable : it is sometimes preferable to acquire several machines but with an equal or higher collective output.

Mobility :
The weight, dimensions and method of moving the machines often defines their suitability for the size or fundamental nature of the project.

Complexity :
Some machines require highly qualified personnel for their organization, operation and maintenance. The lack or impossibility of training personnel of this type necessarily eliminates a certain number of machines. Complexity also implies dependence on sources for the supply of spare parts.

Energy source :
The choice between manual or motor-driven machines is an elimination criterion. The type of motor required may also dictate the choice, depending on the cost and availability of the energy source necessary for the operation of the equipment.

Energy transmission :
The implications of the choice between mechanical and hydraulic transmission systems are fundamental, for they have a decisive influence on the progress of the project. This is particularly true for the following points : maintenance, spare parts, availability of hydraulic fluid, complexity of repairs, etc.

Flexibility :
Not all machines have the flexibility required to produce a range of products not limited to simple variants of the parallelepiped block (paving slabs, tiles, etc.).

Block type :
Not all machines have the features required to manufacture blocks that can satisfy desired performance requirements. Reference to the relevant table of block types may be useful.

Block category :
Not all machines have the features required to manufacture the desired category or categories of blocks. Reference to the relevant list of block categories may be useful.

SHEET A : KEY REQUIREMENTS

Refer to "QUESTIONNAIRE".

ADDITIONAL REQUIREMENTS (B)

PROCEDURE

Selection with additional requirements is not a simple procedure, as it is based on multiple criterion analysis. Significance must be attributed to each chosen criterion so as to establish a hierarchy of criteria. A number of points, on a fixed scale (e.g. 0 to 5), is then attributed to each machine for each criterion. Multiplication of the weight of the criterion by the points obtained by the machine for that criterion gives the score. The sum of the scores for all criteria produces the result for the machine. The system of weights applied to the criteria and of points attributed to the machines must clearly be judiciously set up so as not to falsify the selection mechanism irretrievably.
The machine or machines that clearly stand out from the others will be selected. Small differences between results should not be taken into consideration.

PRINCIPAL CRITERIA: ADDITIONAL REQUIREMENTS

In principle, many criteria can be put forward for this selection, but most of them are socio-economic criteria. Experience shows that the most relevant criteria often include the following (not in order) :

Interchangeability :
The acquisition of machines compatible with other machines already in operation on the same project, region or country may be an advantage.

Development potential :
Rather than installing complex machinery from the start, it may be preferable to begin with an installation which is simple but has good potential for development, leading eventually to complete industrialization.

Job creation :
Some machines are specifically designed to reduce human involvement as much as possible. In contrast, it is sometimes desirable, from both the economic and the social points of view, to create as many jobs as possible associated with the operation of the machines.

Training effects :
In some cases the organizational, operational and maintenance requirements of the machines, if at an appropriate level, can help in the qualification of users and thus prepare them to progress through important stages of the overall development plan.

Suitability :
It is often hoped that immediate transfer of technology will help the development of the population concerned. The technology should therefore be easily imparted to this population and technically appropriate. For this objective to be attained, the technology should above all be culturally and socially acceptable.

Accessibility :
The product resulting from the production process must be economically accessible to the users. If this is not the case various solutions can be envisaged, for example aid in kind, production subsidies, etc.

Financial profitability :
It is not always necessary or desirable to mount operations that are profitable on a micro-economic scale. However, if profitability is desired it will influence machine selection in a specific way.

Competitivity :
Even if it is profitable the operation will not necessarily be competitive with other sectors. This competitivity often results from a market distorted by subsidies.

Foreign currency savings :
Beyond economic factors directly related to the project, it is possible to seek savings in foreign currencies at a macro-economic level.

Partnership :
Certain installations involve partnership imposed by the manufacturer or the dealer. Such partnerships are not always desirable, but in some cases may be an advantage.

SHEET B : ADDITIONAL REQUIREMENTS

Refer to "QUESTIONNAIRE".

FINAL SELECTION (C)

PROCEDURE

Final selection enables the final choice to be made. It is a relatively subjective procedure. Information on machines that correspond to the defined criteria are compared on the final selection sheet, and the final selection is made by an overall assessment, without employing a yes/no procedure or a "multiple criterion analysis".

PRINCIPAL CRITERIA : FINAL SELECTION

In principle, many criteria can be defined for this selection. In general, however, technical criteria are chosen. Experience shows that the most relevant criteria often include the following (not in order) :

Pressure :
This criterion is logically related to the block type criterion. It is imperative to distinguish clearly between compression pressure and available pressure at the end of compression.

Compression mode :
There are certain trends in compression mode. It is worth analyzing very closely the real advantages of the proposed mode.

Compression mechanism :
The quality of the machines, and the quality of the products, is dependent on the compression mechanism.

Compression ratio :
This ratio can play an essential role in the quality of the product, and will thus be the determining factor in a choice between two otherwise identical machines.

Reliability :
Assessment of overall reliability must take several parameters into account, such as : the different mechanical systems, degree of sophistication of automation, sensitivity of components to environmental conditions, etc.

Service life :
Service life estimation should be based on numerous parameters, such as : robustness, quality of materials employed, maintenance frequency, etc.

Safety :
Operator safety should be a decisive factor in the final choice.

Training :
Training provided by the manufacturer can be a very important argument for the acquisition of a particular machine.

Reliability of the manufacturer :
References from customers as well as the manufacturers may play a role in selection. Long term after-sales services is always desirable.

Purchase conditions :
Payment conditions, discounts, etc. Delivery delays depend on the periods required for transport, customs clearance and final routing, as well as the availability of the machine.

SHEET C : FINAL SELECTION

Refer to "QUESTIONNAIRE".

HELP WITH THE DECISION

The following lists and tables are designed to facilitate equipment selection.

FIELD OF UTILIZATION OF PRESSES

Manual presses ; advantages :
— low investment,
— low operating costs (excluding labour),
— minimum weight : easy to transport manually or by wheelbarrow, pack animal, motor vehicle and even aircraft,
— small size,
— simple to use, even for unskilled workers,
— no maintenance difficulties,
— possibility of repair in rudimentary workshops,
— no consumption of non-renewable energy,
— no dependence on energy supply,
— etc.

Manual presses ; disadvantages :
— Low rate of production per machine. Many machines often needed to obtain the required output.
— Low compression usually obtained. Block quality thus not always guaranteed.
— Tendancy to produce blocks of irregular overall quality : considerable variation in size and dry volume mass.
— Operation is tiring : quality is thus very dependent on the degree of tiredness of the operators.
— Low compression at the end of compression often leads to higher binder consumption, if blocks are stabilized.
— etc.

Manual presses ; possible conditions of use :
— labour intensive,
— limited capital resources,
— projects located in very remote regions,
— working area very restricted,
— atmospheric conditions not very rigorous,
— small-scale projects,
— block quality not of prime importance,
— buildings constructed on a self-help basis,
— etc.

Motor-driven presses ; advantages :
— high rate of production,
— compression obtained at end of compression is usually high,
— uniform block quality,
— reduction in quantity of binder required for stabilization,
— reduction in labour, in locations where wages are high,
— etc.

Motor-driven presses ; disadvantages :
— high investment
— delivery time usually long,
— heavy, often requiring lifting gear for transport and installation,
— large size, necessitating a correspondingly large working area,
— workforce must be trained and familiar with machine maintenance,
— intensive maintenance, with a high-level of sophistication,
— technician specialist necessary for maintenance,
— difficulty or delay in obtaining spare parts,
— dependent on non-renewable energy,
— dependent on energy supply,
— etc.

Motor-driven presses ; possible conditions of use :
— adequate financial resources available,
— high output is imperative,
— better quality blocks required,
— regular and sufficient energy available,
— maintenance does not present a problem,
— labour is expensive or not readily available,
— good training is planned,
— etc.

TABLES TO HELP WITH THE DECISION

TECHNICAL CLASSIFICATION OF THE MACHINES

TYPE	ENERGY TRANSMISSION	LOW PRESSURE (< 6 MPA)		HIGH PRESSURE (> 6 MPA)	
		LOW OUTPUT	HIGH OUTPUT	LOW OUTPUT	HIGH OUTPUT
MANUAL PRESSES	MECHANICAL	UNATA 1003 DSM - GÉO 50	TERSTARAM CERAMAN		
	MECHANICAL + HYDRAULIC			BREPAK	
MOTORIZED PRESSES	MECHANICAL	SEMI-TERSTAMATIQUE PACT 500	CERAMATIC		
	HYDRAULIC	DSH			
MOBILE UNITS	HYDRAULIC				
	MECHANICAL + HYDRAULIC		DYNATERRE 01-4M DYNATERRE 01-6M		PRESS-BLOC 80 TM
FIXED UNITS	HYDRAULIC				TMR 6750-40 TEROC T2A
	MECHANICAL + HYDRAULIC		DYNATERRE 03 DYNATERRE 04		

NOTE : Outputs should be compared horizontally and not vertically.

CONDITIONAL CLASSIFICATION OF THE MACHINES

CLASSIFICATION BY COST		CLASSIFICATION BY COUNTRY		CLASSIFICATION BY OUTPUT	
PRICE (ECUs)	MACHINE	COUNTRY	MACHINE	PRACTICAL OUTPUT (m^3/day)	MACHINE
375	UNATA 1003	BELGIUM	CERAMAN	1,3	BREPAK
745	DSM	BELGIUM	CERAMATIC	2	UNATA 1003
860	GÉO 50	BELGIUM	SEMI-TERSTAMATIQUE	2.7	CERAMAN
1 300	TERSTARAM	BELGIUM	TERSTARAM	2.7	TERSTARAM
1 770	CERAMAN	BELGIUM	UNATA 1003	2.7 - 3,3	GÉO 50
1 800	BREPAK	FRANCE	DSH	3.2 - 3,9	DSM
8 400	SEMI-TERSTAMATIQUE	FRANCE	DSM	5.6	DSH
10 700	DSH	FRANCE	DYNATERRE 01-4M	5.9	SEMI-TERSTAMATIQUE
11 400	PACT 500	FRANCE	GÉO 50	8.6	PACT 500
16 700	CERAMATIC	FRANCE	PACT 500	9	CERAMATIC
57 700	TMR 6750-40	FRANCE	PRESS-BLOC 80 TM	9.4	PRESS-BLOC 80 TM
69 000	DYNATERRE 01-4M	FRANCE	TEROC T2A	16.4	TEROC T2A
75 000	PRESS-BLOC 80 TM	FRANCE	TMR 6750-40	17.3	TMR 6750-40
143 000	TEROC T2A	UNITED KINGDOM	BREPAK	26.9	DYNATERRE 01-4M

CLASSIFICATION ACCORDING TO THE STATUTE OF THE PRODUCER

STATUS OF THE PRODUCER	TYPE OF BRICKWORKS	MACHINES
SELF-EMPLOYED BUILDER	TYPE 1 TYPE 2	BREPAK CERAMAN DSM GÉO 50 TERSTARAM UNATA 1003
ARTISAN	TYPE 2 TYPE 3 TYPE 4 TYPE 5 TYPE 6 TYPE 7	BREPAK CERAMAN CERAMATIC DSH DSM GÉO 50 PACT 500 PRESS-BLOC 80 TM SEMI-TERSTAMATIQUE TERSTARAM UNATA 1003
INDUSTRIALIST	TYPE 5 TYPE 6 TYPE 7 TYPE 8	CERAMATIC DYNATERRE 01-4M PACT 500 PRESS-BLOC 80 TM SEMI-TERSTAMATIQUE TEROC T2A TMR 6750-40

NOTE : See also the table "TYPES OF BRICKWORKS".

COMPRESSED EARTH BLOCKS

SELECTION OF PRODUCTION EQUIPMENT

QUESTIONNAIRE

CENTRE
FOR THE DEVELOPMENT
OF INDUSTRY
(ACP-EEC)

APPENDIX I
QUESTIONNAIRE

FILE PRESENTED BY :

COMPANY .....
.....

CONTACT .....
.....

ADDRESS .....
.....
.....
.....

TELEPHONE .....

TELEX .....

TELEFAX .....

If a specific point in the questionnaire is not replied to, it will be assumed that the parameter or criterion is not applicable to the file.

Should you prefer to entrust the selection of your equipment for the installation of a brickworks intended for the production of compressed earth blocks to a neutral expert, please fill in this questionnaire and send it to CDI.

We advise you to fill it in very carefully and fully, and to add as much information as possible :
— plans,
— reports,
— meteorological data,
— geological data,
— etc.

This file must be mailed to :

CENTRE FOR THE DEVELOPMENT OF INDUSTRY
(CDI)
Industrial Operations
Clay Based Industries
rue de l'Industrie 28
B - 1040 BRUSSELS
BELGIUM

SPECIFIC PARAMETERS	
STATUS OF THE BUILDER	
SELF-EMPLOYED BUILDER	
ARTISAN	
INDUSTRIALIST	
PURPOSE OF PROJECT	
IMMEDIATE USE	
COMMERCIAL PRODUCTION	
REGIONAL INDUSTRY	
NATIONAL INDUSTRY	
ENVIRONMENT	
RURAL	
SEMI-URBAN	
URBAN	
PARTICIPANT	
OWNER	
PRIME CONTRACTOR	
BUSINESS	
MODE OF CONSTRUCTION	
SELF-EMPLOYED BUILDER	
ASSISTED PRIVATE CONSTRUCTION	
NON-ASSISTED PRIVATE CONSTRUCTION	
PUBLIC CONSTRUCTION	
PROJECT	
EXACT LOCATION	
TYPE OF BUILDING	
PURPOSE OF BUILDING	
NUMBER OF BUILDINGS	
AREA TO BE BUILT ON	
VOLUME OF MASONRY	
DRAWINGS	
EXECUTION PLAN	

GENERAL PARAMETERS			
DESIGNATION	**UNIT**	**UNIT PRICE**	**TRANSPORT DISTANCE**
WATER AND ENERGY			
WATER	m^3		
ELECTRICITY	kW.h		
PETROL, STANDARD	l		
PETROL, PREMIUM	l		
GAS OIL	l		
FIREWOOD	m^3		
OIL, GREASE AND FLUID			
GREASE	l		
MOTOR OIL	l		
HYDRAULIC FLUID	200 l		
MATERIALS			
EARTH	m^3		
GRAVEL CHIPPINGS 10 mm	m^3		
FINE SAND	m^3		
COARSE SAND	m^3		
CEMENT	T		
LIME	T		
PLASTER	kg		
REINFORCING STEEL	kg		
FORMWORK TIMBER	m^3		
BOARD TIMBER	m^3		
ROUND TIMBER	m^3		

DESIGNATION	**UNIT**	**UNIT PRICE**	**TRANSPORT DISTANCE**
TOOLING, SMALL ITEMS AND SUPPLIES			
BALANCE 10 kg WITH WEIGHTS	unit		
SPRINKLER 12 l	unit		
BUCKET 10 l	unit		
DRUM 200 l	unit		
MEASURING WHEELBARROW 60 l	unit		
FLAT WHEELBARROW	unit		
HAND CART	unit		
BATTEN 4 × 4 cm	m		
WOODEN PALLET 100 × 120 cm	unit		
PLASTIC SHEETING	m^2		
CANVAS SHEETING	m^2		
CHIKEN WIRE	m^2		
SIEVING SCREEN Ø 5-10 mm	m^2		
SIEVING SCREEN Ø 15-20 mm	m^2		
SMALL NAILS	kg		
WOODWORK NAILS	kg		
SHOVEL	unit		
PICK	unit		
HOE	unit		
RAKE	unit		
HAMMER	unit		
TONGS	unit		
TROWEL	unit		
SPATULA	unit		
PLUMB LINE	unit		
MASON'S RULE	unit		
SPIRIT LEVEL	unit		
WIRE BRUSH	unit		
OIL CAN	unit		
SMALL BRUSH	unit		
MECHANIC'S TOOL BOX	unit		
PAIR OF SAFETY GLOVES	unit		
FIRST AID KIT	unit		
TRANSPORT AND COMMUNICATIONS			
TRANSPORT BY PACK ANIMAL	km		
TRANSPORT BY CART	km		
TRANSPORT BY PICK-UP	km		
TRANSPORT BY TIPPER LORRY	m^3/km		
TRANSPORT BY FLATBED LORRY	m^3/km		
TRANSPORT OF PERSONNEL	km		
URBAN ZONE TELEPHONE	minute		
INTERNATIONAL TELEPHONE	minute		
TELEX	line		
FACSIMILE TRANSMISSION	page		

DESIGNATION	UNIT	UNIT PRICE	TRANSPORT DISTANCE
LABOUR			
LABOURER	day		
SKILLED WORKER	day		
NOVICE MASON	day		
EXPERIENCED MASON	day		
MACHINE OPERATOR	day		
LORRY DRIVER	day		
NOVICE MECHANIC	day		
EXPERIENCED MECHANIC	day		
WATCHMAN	day		
HOURS WORKED / DAY	hour		
DAYS WORKED / YEAR	day		
EMPLOYER SOCIAL SECURITY PAYMENTS	%		
MISCELLANEOUS BONUSES	%		
MANAGEMENT			
OVERSEER OR FOREMAN	month		
SITE CHIEF OR TECHNICIAN	month		
EMPLOYER SOCIAL SECURITY PAYMENTS	%		
MISCELLANEOUS BONUSES	%		
MEAN OUTPUT			
LIGHT SOIL EXCAVATION	m^3/hour		
HARD EARTH EXCAVATION	m^3/hour		
TRANSPORT BY WHEELBARROW	m^3/hour		
SHOVEL SCREENING	m^3/hour		
SHOVEL MIXING	m^3/hour		
PRODUCTION ENVIRONMENT			
QUARRY AREA	m^2		
BRICKWORKS AREA	m^2		
RAMMING	m^2		
COARSE CONCRETE PAVING	m^2		
WATER CONNECTION	unit		
ELECTRICITY CONNECTION	unit		
TELEPHONE CONNECTION	unit		
LORRY ACCESS ROAD	unit		
WELL	unit		
TANK 2 m^3	unit		
FENCING	m		
WATCHMAN'S HUT	unit		
WATERPROOF STORAGE	m^2		
SHED	m^2		

DESIGNATION	UNIT	UNIT PRICE	TRANSPORT DISTANCE
CURRENCY			
LOCAL MONETARY UNIT	unit		
FOREIGN CURRENCY IN ECU	unit		
FOREIGN CURRENCY IN FRENCH FRANCS	unit		
FORREIGN CURRENCY IN US $	unit		
IMPORT CHARGES			
TAXES ON TOOLS	%		
TAXES ON LIGHT MACHINERY	%		
TAXES ON HEAVY MACHINERY	%		
TAXES ON PICK-UP	%		
TAXES ON LORRIES	%		
TAXES ON PUBLIC WORKS EQUIPMENT	%		
CUSTOMS DUTY	%		
TRANSHIPMENT CHARGES	%		
STORAGE CHARGES	%		
PROPERTY DEPRECIATION			
LEGAL PERIOD	month		
DESIRED PERIOD	month		
LEGAL RATE	%		
DESIRED RATE	%		
DEPRECIATION OF TOOLS			
LEGAL PERIOD	month		
DESIRED PERIOD	month		
LEGAL RATE	%		
DESIRED RATE	%		
DEPRECIATION OF LIGHT MACHINERY			
LEGAL PERIOD	month		
DESIRED PERIOD	month		
LEGAL RATE	%		
DESIRED RATE	%		
DEPRECIATION OF HEAVY MACHINERY			
LEGAL PERIOD	month		
DESIRED PERIOD	month		
LEGAL RATE	%		
DESIRED RATE	%		
DEPRECIATION OF PICK-UPS			
LEGAL PERIOD	month		
DESIRED PERIOD	month		
LEGAL RATE	%		
DESIRED RATE	%		

DESIGNATION	UNIT	UNIT PRICE	TRANSPORT DISTANCE
DEPRECIATION OF LORRIES			
LEGAL PERIOD	month		
DESIRED PERIOD	month		
LEGAL RATE	%		
DESIRED RATE	%		
DEPRECIATION OF PUBLIC WORKS EQUIPMENT			
LEGAL PERIOD	month		
DESIRED PERIOD	month		
LEGAL RATE	%		
DESIRED RATE	%		
FINANCIAL AND INSURANCE CHARGES			
TURNOVER TAX	%		
PROFITS TAX	%		
TARGET PROFIT MARGIN	%		
LOCAL TAXES	%		
LOAN REPAYMENTS	per year		
PROPERTY INSURANCE	per year		
EQUIPMENT INSURANCE	per year		
VEHICLE INSURANCE	per year		

PRINCIPAL CRITERIA : KEY REQUIREMENTS	
CONDITIONS	**ORDER**
COST	
SOURCE	
OUTPUT	
MOBILITY	
COMPLEXITY	
ENERGY SOURCE	
ENERGY TRANSMISSION	
FLEXIBILITY	
BLOCKS TYPE	
BLOCKS CATEGORY	

NOTE :
Order = 0 for the irrelevant criteria.
Order = 1 for the selected criteria.

PRINCIPAL CRITERIA : ADDITIONAL REQUIREMENTS	
REQUIREMENTS	**WEIGHT**
INTERCHANGEABILITY	
DEVELOPMENT POTENTIAL	
JOB CREATION	
TRAINING EFFECTS	
SUITABILITY	
ACCESSIBILITY	
FINANCIAL PROFITABILITY	
COMPETITIVITY	
FOREIGN CURRENCY SAVINGS	
PARTNERSHIP	

NOTE :
Weight = 0 for the irrelevant criteria.
Weight = 1 to 10, or more (1 for the least relevant criterion to 10 or more for the most relevant criterion).

PRINCIPAL CRITERIA : FINAL SELECTION	
PREFERENCES	**ORDER**
PRESSURE	
COMPRESSION MODE	
COMPRESSION MECHANISM	
COMPRESSION RATIO	
RELIABILITY	
SERVICE LIFE	
SAFETY	
TRAINING	
RELIABILITY OF THE MANUFACTURER	
PURCHASE CONDITIONS	

NOTE :
Order = 0 for the irrelevant criteria.
Order = 1 for the selected criteria.

SHEET A : KEY REQUIREMENTS

			RESULTS	SELECTED CRITERIA											
MACHINES	1	BREPAK													
	2	CERAMAN													
	3	CERAMATIC													
	4	DSH													
	5	DSM													
	6	DYNATERRE 01-4M													
	7	GÉO 50													
	8	PACT 500													
	9	PRESS-BLOC 80 TM													
	10	SEMI-TERSTAMATIQUE													
	11	TEROC T2A													
	12	TERSTARAM													
	13	TMR 6750-40													
	14	UNATA 1003													
	15														
	16														
	17														
	18														
	19														
	20														
	21														
	22														
	23														
	24														
	25														

SHEET B : ADDITIONAL REQUIREMENTS

			RESULTS	SELECTED CRITERIA											
		WEIGHT													
MACHINES	1	BREPAK													
	2	CERAMAN													
	3	CERAMATIC													
	4	DSH													
	5	DSM													
	6	DYNATERRE 01-4M													
	7	GÉO 50													
	8	PACT 500													
	9	PRESS-BLOC 80 TM													
	10	SEMI-TERSTAMATIQUE													
	11	TEROC T2A													
	12	TERSTARAM													
	13	TMR 6750-40													
	14	UNATA 1003													
	15														
	16														
	17														
	18														
	19														
	20														
	21														
	22														
	23														
	24														
	25														

SHEET C : FINAL SELECTION

			RESULTS	SELECTED CRITERIA												
MACHINES	1	BREPAK														
	2	CERAMAN														
	3	CERAMATIC														
	4	DSH														
	5	DSM														
	6	DYNATERRE 01-4M														
	7	GÉO 50														
	8	PACT 500														
	9	PRESS-BLOC 80 TM														
	10	SEMI-TERSTAMATIQUE														
	11	TEROC T2A														
	12	TERSTARAM														
	13	TMR 6750-40														
	14	UNATA 1003														
	15															
	16															
	17															
	18															
	19															
	20															
	21															
	22															
	23															
	24															
	25															

APPENDIX II
SERVICES OFFERED

CDI

CDI
Centre for the Development of Industry
(ACP-EEC Lomé Convention)

rue de l'Industrie 28
B - 1040 BRUSSELS
BELGIUM
Telephone : (32) 2 513 41 00
Telex : 61427 cdi b
Telefax : (32) 2 511 75 93

CDI (Centre for the Development of Industry) was founded in 1977 under the Lomé Convention. Its main role is help to create or improve industries, in the ACP (African, Carribean and Pacific) States through cooperation with EEC (European Economic Community) industries.

Within the limits of its resources, CDI undertakes any action which promotes the establishment, the expansion or the rehabilitation of an industrial enterprise in an ACP country. These actions might take the form of an economic analysis, or of commercial and technical assistance. They are intended for businessmen as well as for the governments of the countries. The most important role of CDI is that of adviser and neutral, informed mediator in the setting up of joint ventures and other forms of cooperation between ACP industrialists (or governmental organizations) and EEC industrialists.

CDI gives priority to the promotion of projects requiring limited investment and enabling employment to be created at a reasonable cost. The intention is to establish enterprises generating high annual added value and/or savings in foreign currency proportional to the investment, while complying with the development priorities of the ACP countries.

Initially, CDI takes steps to identify and put in contact, partners with convergent interests. Once these partners are truly committed to the success of the enterprise, the services of CDI are placed at their disposal.

CDI is not able to invest itself, but it can encourage useful contacts with sources of finance.

In addition to the fields of involvement cited above, assistance from CDI can take the following forms :
— promotion and negotiation of joint ventures,
— techno-economic and commercial evaluation,
— studies on the potential of the product and feasibility studies,
— technologies specifically adapted to the ACP countries,
— technical advice for the expansion and recovery of enterprises,
— training and improvement in the level of expertise of technicians and supervisory personnel.

However, each proposal is unique, and the requirements vary from case to case. The objective of CDI is to ensure that all the projects which it aids are seen through to completion

CDI can also supply industrial information such as sources for the purchase of specific items of equipment, free of charge.

An important aspect of CDI assistance is the adaptation of technology to meet the requirements of ACP countries. This adaptation can be effected not only within the framework of development projects specifically designed and planned for this objective, but also through the adaptation of European enterprises to the ACP environment. This might include the redeployment of various elements of existing EEC enterprises

Appropriate technologies that have been proven in the developing countries have been evaluated by CDI, which can provide information on the technologies concerned. This type of information can be particularly useful in the context of the establishment of new enterprises, or the expansion or rehabilitation of existing ACP enterprises.

Many obstacles must be overcome to establish industrial enterprises in ACP countries. These include : the training of production supervisors and managers, market development, contract negotiation, equipment selection, etc.

CDI staff includes industrial experts who can help to resolve some of the problems posed. If necessary CDI can turn to external assistance, thanks to its many contacts in ACP and EEC industrial circles.

ACP promoters will obtain aid from CDI more easily if they associate with local development or finance institutions that are involved in industrial or rural development. If a serious demand is supported by a public or semi-public institution, it will have a better chance of being considered.

EEC enterprises are more willing to take the risk of investing in ACP countries that they may not know, if the projects are backed by reliable financial institutions. Similarly, ACP promoters and development institutions should be committed to contributing to the cost of studies and their follow-up. Without such commitment it is difficult for CDI to justify financial or any other type of involvement, and the chances of finding an EEC partner are reduced.

It is advisable to write to CDI, giving a brief account of the purpose of your request. CDI will then inform you of the steps to take and the type of initial assistance it may be able to offer.

CRATerre

CRATerre
International Centre for the Research and the Application of Earth Construction.

Centre Simone Signoret
BP 53
F-38090 VILLEFONTAINE
FRANCE
Telephone : (33) 74 96 60 56
Telex : 308 658 F CRATERE
Telefax : (33) 76 22 72 56

CRATerre (International Centre for the Research and the Application of Earth Construction) is an association whose associate members are highly qualified international professionals. The statutes of the association set the following objectives for the Centre :
— to encourage local autorities to assume responsability for spacial development and town planning,
— to improve housing conditions of underprivileged populations,
— to encourage the inhabitants directly involved, to create and control the conditions of their own way of life.

GENERAL COMPETENCE

Application :
CRATerre is operational in the field ; it conceives and executes projects as well as providing technical and architectural assistance. Its associate members have been, or still are, active is numerous countries such as : Algeria, Federal Republic of Germany, Saudi Arabia, Burkina Faso, Burundi, Chili, France, French Guyana, Mali, Morroco, Mauritania, Mayotte, Peru, Rwanda, Somalia, Sudan, etc.

Training :
In collaboration with the School of Architecture of Grenoble and the University of Science, Technology and Medecine of Grenoble, CRATerre supervises a two year post-graduate course leading to a Certificate of Advanced Studies in Earth Architecture (CEAA-Terre) ratified by the Department of Architecture and Town Planning of the Ministry "de l'Equipment, du Logement, de l'Aménagement du Territoire et des Transports." Short training courses designed for high level collaborators have also been held in several countries : Burundi, France, Mexico, Peru, etc.
Introductory and professional training sessions are regularly organized for, and in collaboration with, various international organizations, whether private, public or non-governmental.

Research :
CRATerre defines and draws up research programmes and collects know-how on an international scale.
The Centre's private documentary base is composed of a library containing more than 3 000 specialized documents, a bibliographic file with over 5 000 references and a slide collection consisting of 20 000 slides. A network of over 3 500 contacts, of which 500 are permanent sources, enables the Centre to keep this data bank up to date.

Dissemination :
CRATerre publishes technical and scientific works, prepares educational and audio-visual material and participates in the organization of symposiums, the editing of revues and the production of films.

SETTING UP BRICKWORKS

CRATerre offers technical assistance for the setting up of brickworks, at all levels. The assistance extends from project identification to evaluation, concerning such item as organization of complete production lines. It is not limited to the sole problem of production, but also includes involving areas such as application : structure and architecture.

Preliminary study :	— identification, — selection of equipment, — feasibility, — programming, — operation planning.
Architecture and project implementation control :	— rough draft of the project, — project, — project implementation, — technical specifications.
Research and studies :	— social economic study, — site and climatic conditions, — building materials, — structural prototypes, — dimensioning.
Construction and assistance :	— management of the project, — construction site organization, — professional training.
Evaluation :	— socio-economic analysis, — technical assessment.

APPENDIX III
BIBLIOGRAPHY

BIBLIOGRAPHY

The current literature on earth construction includes more than 3 000 titles. This is a selection of readily-available European publications, containing technical information relevant to the subject : compressed earth blocks.

Raw earth construction : the French equipment.
CRATerre : Houben H. and Verney P.E. ;
ENTPE : Olivier M., Mesbah A. and Michel Ph.
CRATerre, Grenoble, France, 1987.

Small-scale manufacture of stabilised soil blocks.
Technology series. Technical memorandum nº 12.
Smith R.G. and Webb D.J.T.
ILO, Geneva, Switzerland, 1987.

Soil block press. Product information leaflets.
Mukerji K. and CRATerre.
GATE, Eschborn, FRG, 1988.

Blocs de terre comprimée : choix du matériel de production.
CRATerre : Houben H. and Verney P.E.
CDI, Brussels, Belgium, 1988.

Construction en terre crue : les matériels français.
CRATerre : Houben H. and Verney P.E. ;
ENTPE : Olivier M., Mesbah A. and Michel Ph.
CRATerre, Grenoble, France, 1987.

Construire en terre
CRATerre : Doat P., Hays A., Houben H., Matuk S. and Vitoux F.
Editions Alternatives, Paris, France, 1985 (3rd printing).

Traité de construction en terre.
L'encyclopédie de la construction en terre.
CRATerre : Houben H. and Guillaud H.
Editions Parenthèses, Marseille, France, 1988.

Typesetting by Burtey Services Compo, Saint-Martin-d'Hères, France.
Printed and bound by Imprimerie GUIRIMAND, Grenoble, France.
Page layout by Pierre-Eric VERNEY, CRATerre, Villefontaine, France,
with the collaboration of Sarah CARDOSO and Diarmuid PEAVOY (CDI).
1st printing, 1 200 copies, January 1989.

This guide discusses the selection of equipment intended for the production of compressed earth blocks.

An inventory of equipment currently marketed by firms from EEC (European Economic Community) States is included.

In order to help entrepreneurs in ACP (African, Carribean and Pacific) States to make an appropriate choice, the equipment is presented in a uniform manner throughout. This facilitates comparison of the various features.

An equipment selection procedure is proposed, based on criteria which are described in detail.

The guide includes a questionnaire. When filled in, this questionnaire should enable decision-makers to select their own equipment in full awareness of the facts, or to entrust selection to a neutral specialist organization.

CRATerre
Centre Simone SIGNORET - BP 53
38090 VILLEFONTAINE - France